VOLUME XVII NOVEMBER, 1934 NUMBER 11

JOURNAL OF DAIRY SCIENCE

PUBLISHED BY THE
AMERICAN DAIRY SCIENCE ASSOCIATION

Contents

Some physico-chemical properties of lactose. V. The influence of other substances upon the equilibrium rotation of lactose. R. L. Herrington 701

Birth-weight, gestation period, and sex ratio of Holstein hybrid Holstein-galloway calves. W. T. Watts 709

Methods for testing frozen cream. H. C. Troyer and W. B. Combs 717

Certain foam producing substances of milk. S. Arbuckle, G. E. Fleischer and G. C. Supplee 723

Manure fertilization results. R. H. Lush and J. L. Fletcher 732

Progress report on comparison of lactation and yearly records. C. M. Hansen, Jay L. Lush and C. N. Shuyler 737

Members of American Dairy Science Association, July 15, 1934 743

American Dairy Science announcements 757

THE SCIENCE PRESS PRINTING COMPANY
LANCASTER, PENNSYLVANIA

Made in United States of America

JOURNAL OF DAIRY SCIENCE

VOLUME XVII NOVEMBER, 1934 NUMBER 11

SOME PHYSICO-CHEMICAL PROPERTIES OF LACTOSE

V. THE INFLUENCE OF OTHER SUBSTANCES UPON THE EQUILIBRIUM ROTATION OF LACTOSE

B. L. HERRINGTON

Department of Dairy Industry, Cornell University, Ithaca, N. Y.

INTRODUCTION

In 1903, Hudson (7) suggested that the mutarotation of lactose was due to a dynamic equilibrium between the two forms. He assumed that these two forms were beta anhydride and lactose hydrate. In 1904, he published another paper (8) in which he stated that, " . . . the mutarotation of milk sugar results from the slow establishment in cold solution of the balanced reaction,

$$\underset{\text{hydrate}}{C_{12}H_{24}O_{12}} = H_2O + \underset{\text{beta anhydride.}}{C_{12}H_{22}O_{11}}$$

In 1910, he published another paper (9) asserting that the mutarotation was due to a slow reversible transformation of the hydrated sugar into a lactone. In his papers on lactose, he assumed that lactose hydrate was the aldehydrol form, and that when alpha anhydride was dissolved in water, it was changed at once into this form. However, he admitted that there was no direct evidence to show that the freshly dissolved hydrate existed in the hydrated condition.

Gillis (4) has denied that hydrated lactose is the hydrated aldehyde related equally to both alpha and beta lactose, and in the opinion of the writer, Gillis is correct. The fact that hydrated lactose is a hydrate of alpha does not necessarily eliminate the reaction given above as a possible explanation of the mutarotation. However, if this equation does represent conditions as they exist in solution, then the equilibrium should vary with the water concentration and this fact should be susceptible of experimental demonstration.

Some information is available in the literature which has a bearing on this problem. Browne (2, p. 188) in writing of the equilibrium rotation of sugars stated, "Highly concentrated solutions, however, do not always

give the true end rotation; such solutions must first be diluted and then allowed to stand for the change in rotation to be completed." This does not seem to be true of lactose. The United States Bureau of Standards has reported (17) that the specific rotation of lactose remains unchanged at all concentrations. It may be argued, of course, that because of its low solubility, solutions of lactose are not sufficiently concentrated for changes in the water concentration to be evident.

In 1880, Tollens (13) found that the specific rotation of sucrose was raised slightly in solutions of ethyl or methyl alcohol as well as in solutions of acetone. However, sucrose is not a mutarotating sugar. In 1895, Tanret (12) reported that the specific rotation of glucose varied with the concentration, increasing from 52.5 to 55.0 in the most concentrated solution examined. The specific rotation was also increased in solutions of alcohol. Trey (14) also reported that the specific rotation of glucose was increased in solutions of methyl alcohol. Trey (16) found that the specific rotation of lactose was decreased in solutions of ethyl or methyl alcohol and in solutions of acetone. Holty (5) found that the specific rotation of lactose was decreased in pyridine solutions, but the decrease was less when the concentration of lactose was high. However, Pucher and Dehn (11) claimed that lactose combines with pyridine, and therefore interpretation of Holty's data is difficult.

It is quite evident that the experimental results seem to support Hudson's theory as expressed by his equation. However, before considering the question as settled, an attempt was made to gather additional evidence. It was desired to lower the water concentration as much as possible and determine the effect upon the alpha-beta equilibrium. Lactose is practically insoluble in anhydrous alcohol but it is appreciably soluble in glycerol. Glycerol was therefore chosen as the solvent to be used in this investigation. Experiments were also planned to determine whether such salts as calcium chloride, which would bind part of the water in the solution, might alter the equilibrium between the mutarotating forms.

The mere fact that the specific rotations of lactose in glycerol and in water were different would not constitute proof that a shift in the equilibrium had taken place. However, if the equilibrium in gycerol were not the same as in water, then it should be possible to detect mutarotation after diluting the glycerol solutions with a large volume of water. This test was employed in the following experiments.

EXPERIMENTS

Three solutions, each containing 1.500 grams of lactose, were prepared. The solvents used were: 1, 25 grams of c.p. glycerol; 2, 25 grams of c.p. glycerol + 70 cc. of water; 3, 70 cc. of water. The lactose was dissolved by heating the flasks in hot water. Then, the solutions were cooled to room

temperature, diluted to 110 cc. with water, and read as quickly as possible in a 400 mm. water jacketed polariscope tube at 26° C. The solution equilibrated in glycerol gave a rotation of 3.03°; the solution equilibrated in aqueous glycerol gave a reading of 2.80°; the solution equilibrated in water gave a reading of 2.83°. When the first solution was warmed at 80° C. for five minutes and then reexamined in the polariscope, the rotation was found to be 2.80°.

The high value found for the glycerol solution was open to suspicion since the solution was prepared from the form of lactose having high rotation. Therefore, the experiment was repeated starting with beta anhydride, and taking particular care that equilibrium should be established before diluting with water. The glycerol was freed from water by heating to 150° C., under reduced pressure. Beta lactose was then dissolved in it by heating to 120° C. The solution was held at 100° C., for 48 hours. After cooling, the solution was diluted with four volumes of water, and examined at once in a polariscope. The first reading was 6.57, the final rotation was 6.15. It is of interest to note that the fall in rotation is 6.4 per cent in this experiment and 6.6 per cent in the previous one. Therefore, we may safely assume that equilibrium had been established in both experiments.

These experiments indicated that in glycerol there was a shift toward the more strongly rotating form of lactose, although the reverse is reported for alcoholic solutions. In aqueous solutions, such a shift normally occurs at elevated temperatures. If this is true in glycerol, and if equilibration is very slow in glycerol, there is a possibility that, in spite of slow cooling, the measurements really apply to the equilibrium at some high temperature which was "frozen" on cooling. This might have caused an error in these experiments, but that is not believed to be the case.

Somewhat similar experiments were carried out using solutions of salts and in most cases the equilibrium rotation was raised. An increase in rotation cannot be explained in terms of the original equation. Therefore, it seemed that some complicating factor was present. If this were true, then the data, obtained in the study of salt solutions, could not be used to solve the original problem regarding the condition of lactose in solution. Therefore, that part of the investigation was discontinued for the time being.

Trey (16) studied the mutarotation of lactose in salt solutions. He was interested primarily in the velocity of mutarotation, but incidentally he showed that some salts influence the equilibrium rotation. In order to determine if this was a general property of all salts, weighed amounts of various salts were placed in 50 cc. volumetric flasks. Twenty-five cc. of a concentrated solution of lactose was then added to each flask, with sufficient water to bring the solution almost to the mark. After the salt had dissolved completely, the volume was adjusted to 50 cc. and then the flasks

were heated in hot water to approximately 70° C. They were allowed to cool slowly to room temperature and finally examined in a polariscope using a water jacketed tube. The data are shown in Table 1. After making the initial observation, some of the solutions were diluted with water and placed in the polariscope. The diluted solutions exhibited mutarotation.

TABLE 1

The influence of various salts on the equilibrium rotation of lactose

SALT USED	GRAMS OF SALT	CC. OF SUGAR SOLUTION	ROTATION	SHIFT
		First series		
None	0	25	20.34	
$BaCl_2$	10	25	21.40	+1.06
$Ca(NO_3)_2 \cdot 4H_2O$	20	25	22.13	+1.79
		Second series		
None	0	25	20.14	
KI	10	25	20.25	+0.11
$NaNO_3$	10	25	20.93	+0.79
$Ca(NO_3)_2 \cdot 4H_2O$	15	25	21.20	+1.06
		Third series		
None	0	25	10.07	
$MgCl_2 \cdot 6H_2O$	15	25	10.28	+0.21
$BaCl_2 \cdot 2H_2O$	15	25	10.63	+0.56
$HgCl_2$	3	25	10.09	+0.02
KCl	15	25	9.78	−0.29
		Fourth series		
None	0	25	28.24	
NaCl	12	25	29.37	+1.13
$K_2SO_3 \cdot 2H_2O$	15	25	25.97	−2.27
NaBr	15	25	29.16	+0.92
NH_4Cl	14	25	27.30	−0.94

These experiments showed that practically all salts, if sufficiently concentrated, influence the equilibrium rotation of lactose, but the effect is not uniform. Of the salts examined, all except potassium sulphite, and the chlorides of ammonium and potassium, raised the final rotation. These three salts lowered it. Trey (15) definitely stated that he did not believe that the abnormal mutarotations which he observed in salt solutions were due to compounds of sugar and salt existing in solutions. He points out that even though, in some cases, such compounds are known in the solid state, there is no proof that they exist in solution. The view that lactose combines to some extent with practically all salts in solution is accepted with reluctance. However, no other theory seemed to be quite so simple, and it was thought desirable either to prove or disprove it.

If the abnormal equilibrium rotation is due to the formation of a compound of lactose and a salt, then by increasing either the lactose concentration, or the salt concentration, compound formation should be favored. As the salt concentration increases, the rotation should rise steadily and approach a constant value, which would be reached when all of the sugar is in the form of the compound. As the lactose concentration increases, the total deviation should increase, but the actual specific rotations would not reach the high value that was found in the first case. Furthermore, the specific rotation might even pass through a maximum and then decrease again. This is necessarily true, since there must always be present a large excess of free sugar. These predictions were found to fit the three cases which were examined in detail.

Concentrated solutions of calcium chloride, calcium nitrate, and potassium chloride were prepared from Baker's Analyzed chemicals. Their concentrations were not determined exactly since they did not seem of particular importance. A series of solutions were prepared from the stock salt solutions, pure lactose, and distilled water. In each case, the final volume was adjusted to 50 cc. The solutions were heated for a minute or two in boiling water to establish equilibrium. Then they were cooled slowly, and examined in a polariscope. The data are shown in Tables 2 and 3.

TABLE 2

The effect of salt concentration upon the equilibrium rotation of lactose

cc. of $CaCl_2$ solution	grams of lactose	rotation	rotation per gram	total deviation
0	2.000	8.23	4.11	
10	2.000	8.67	4.33	+ 0.44
20	2.000	8.86	4.43	+ 0.63
30	2.000	9.19	4.59	+ 0.96
40	2.000	9.40	4.70	+ 1.17
to 50 cc.	2.000	9.66	4.83	+ 1.43
0	4.000	16.36	4.09	
10	4.000	17.15	4.29	+ 0.79
20	4.000	18.20	4.54	+ 1.84
30	4.000	18.92	4.73	+ 2.56
40	4.000	19.17	4.79	+ 2.81
50	0	0		

The calcium chloride solution contained 43.95% of anhydrous salt by weight.

A study of these tables shows that the shift in specific rotation depends upon the concentration of both salt and sugar in the way which would be expected if a compound did exist in solution. The degree of association cannot be estimated without knowing the specific rotation of the compound itself.

TABLE 3

The variation of the equilibrium rotation in salt solution with change in lactose concentration

SALT USED	CC. OF SALT SOLUTION	GRAMS OF LACTOSE	ROTATION	ROTATION PER GRAM	TOTAL DEVIATION
Calcium nitrate	0	7.000	28.32	4.05	
" "	10	2.000	8.43	4.22	+ 0.33
" "	20	2.000	8.69	4.35	+ 0.59
" "	20	4.000	17.57	4.39	+ 1.37
" "	20	8.000	35.22	4.40	+ 2.82
" "	40	2.000	9.43	4.72	+ 1.33
" "	40	4.000	19.05	4.76	+ 2.85
" "	40	8.000	38.38	4.79	+ 5.98
Calcium chloride	10	4.000	16.90	4.23	+ 0.70
" "	20	2.000	8.53	4.27	+ 0.43
" "	20	4.000	17.71	4.43	+ 1.51
" "	20	8.000	35.77	4.47	+ 3.37
" "	40	2.000	9.13	4.57	+ 1.03
" "	40	4.000	18.43	4.61	+ 2.23
" "	40	8.000	38.33	4.78	+ 5.93
Potassium chloride	to 50 cc.	1.000	3.94	3.94	− 0.11
" "	"	3.000	11.90	3.97	− 0.25
" "	"	5.000	19.88	3.98	− 0.37
" "	"	7.000	27.84	3.98	− 0.41

Calcium nitrate solution: 400 grams $Ca(NO_3)_2 \cdot 4H_2O$ plus 250 cc. of water.
Calcium chloride solution: 570 grams of anhydrous $CaCl_2$ per liter.
Potassium chloride solution: 340 grams plus 1000 cc. of water.

The results of these experiments support the theory that lactose forms compounds with salts in solutions. The literature of lactose gives little information regarding this point. Dubrunfaut (3) and Hönig and Rosenfeldt (6) have prepared sodium salts of lactose. These salts are formed in alkaline solutions, and that doubtless accounts for the fact that at high pHs the equilibrium rotation is reduced. According to Bleyer and Schmidt (1), the original value is restored by neutralization of the alkali. Levy and Doisy (10) also found that lactose unites with borates in solutions, though the action is not pronounced. The work of Trey (16) has already been mentioned.

SUMMARY

In glycerol solutions, the equilibrium mixture of the high and low rotating forms of lactose contains more of the high rotating component than is found in aqueous solutions.

The specific rotation of lactose is increased in glycerol solutions but, according to other workers, it is decreased in alcoholic or acetone solutions.

Therefore, it may be assumed that water is not an important factor in determining the ratio of the sugars at equilibrium.

This implies that the amount of aldehydrol present in solution is small, or else that its specific rotation is approximately equal to the weighted mean of the rotations of the two anhydrides, taking their equilibrium concentrations into consideration.

The specific rotation of lactose is altered by the presence of salts. The effect is small in dilute solutions.

Changes in the concentration of lactose, or of the salt, result in shifts of the equilibrium rotation which are in agreement with the theory that molecular compounds are formed in salt solutions.

REFERENCES

(1) BLEYER, B., AND SCHMIDT, H. Studien über das Verhalten der wichtigsten Kohlenhydrate in stark saur alkalischer sulfit und bisulfithaltiger Lösung. III. Einwirkung von Alkalien auf der Kohlenhydrate. Biochem. Z. **141**: 278–96. 1923.

(2) BROWNE, C. A. A Handbook of Sugar Analysis. 1st edition, p. 25. John Wiley and Sons, New York. 1912.

(3) DUBRUNFAUT. Note sur le sucre de lait. Compt. rend. **42**: 228–33. 1856.

(4) GILLIS, J. Nouvelles recherches sur le sucre de lait. Rec. trav. chim. **39**: 88–125. 1920.

(5) HOLTY, JOSEPH GERARD. Solubility and specific rotatory power of carbohydrates and certain organic acids and bases in pyridine and other solvents. J. Phys. Chem. **9**: 764–79. 1905.

(6) HÖNIG, M., AND ROSENFELD, M. Zur Kenntniss einiger Zuckerarten. Ber. **12**: 45–7. 1879.

(7) HUDSON, C. S. Über die Multirotation des Milchzuckers. Z. physik. Chem. **44**: 487–94. 1903.

(8) HUDSON, C. S. The hydration of milk sugar in solution. J. Am. Chem. Soc. **26**: 1065–82. 1904.

(9) HUDSON, C. S. A review of discoveries on the mutarotation of sugars. J. Am. Chem. Soc. **32**: 889–94. 1910.

(10) LEVY, MILTON, AND DOISY, EDWARD A. The reaction of borate and sugars. II. The optical activity of sugars in borax solutions and the configuration of mutarotatory isomers. J. Biol. Chem. **84**: 749–62. 1929.

(11) PUCHER, GEORGE, AND DEHN, W. M. Solubilities in mixtures of two compounds. J. Am. Chem. Soc. **43**: 1753–58. 1921.

(12) TANRET, C. Sur les modifications moleculaires du glucose. Bull. soc. chim. (3) **13**: 728–35. 1895.

(13) TOLLENS, B. Ueber die specifische Drehung des Rohrzuckers in verschieden Lösungmittel. Ber. **13**: 2297–2302. 1880.

(14) TREY, HEINRICH. Experimentalbeitrag zur Birotation der Glykose. Z. physik. Chem. **18**: 193–218. 1895.

(15) TREY, HEINRICH. Ein weiter Beitrag zur Birotation der Glycose. Z. physik. Chem. **22**: 424–63. 1897.

(16) TREY, HEINRICH. Ein Beitrag zu den Rotationserscheinungen der Laktose. Z. physik. Chem. **46**: 620–719. 1903.

(17) U. S. Bureau of Standards. Polarimetry. U. S. Bureau of Standards, Circular No. **44**: p. 150. 1917.

BIRTH-WEIGHT, GESTATION PERIOD, AND SEX RATIO OF ALASKAN HYBRID HOLSTEIN-GALLOWAY CALVES

W. T. WHITE

Alaska Agricultural Experiment Stations, Kodiak, Alaska

The birth-weight, gestation period, and proportion of female calves are of general interest to all dairy cattle breeders. There is included herewith data recorded by the author, upon the length of gestation, birth-weight, and a ratio of sexes for hybrid, Holstein-Galloway cattle of the Alaska Agricultural Experiment Stations during the period of 1917–1932.

The purpose of the original experiment, from which the data were taken, was that of producing a hardy dairy cow for Alaska. The work had progressed to point where a number of hybrid cows were producing more than 10,000 pounds of milk and 400 pounds of butterfat per lactation. The project, supported by Department of Agriculture appropriation, was abandoned July 1, 1932, and the supervision of the work turned over to the Alaska Agricultural College and School of Mines.

The original breeding experiment was begun by making fifteen matings between registered Holstein bulls and registered Galloway cows. Later, ten reciprocal matings were made between the Galloway bulls and Holstein cows, as well as a number of backcrosses, when a limited number of hybrid cows were mated to Holstein or Galloway bulls. (Tables 1 and 1a.)

GESTATION PERIOD

The number of days from date of breeding to parturition was recorded for the Holstein-Galloway hybrids. Both breeding and parturition dates were included in the period of gestation calculations.

There appears to be no significant difference in the length of gestation between the hybrid females and the hybrid males of this herd. A mean of 282.9 ± 3.2 days was found to be the average period of gestation for the 116 hybrid calves. Fifty-five were males, which were carried by their dams for an average gestation of 282.8 ± 3.4 days, while 61 females were carried an average of 283.1 ± 3.0 days. (Figure 1.) Thirty of the 55 males were carried by their dams between 279 to 286 days. Ten of the 55 males, 18.1 per cent, were carried 279 days or less. Fifteen, 27.2 per cent, were carried 286 days or more. Forty-five of the females were carried by their dams from 280 days to 286 days. Five of the 61 females, 8.3 per cent, were carried 279 days or less, while 11, 18.0 per cent, were carried 286 days or more. The shortest gestation was for each of two hybrid males, a period of 269 days each. The shortest hybrid female gestation was 270

Received for publication June 1, 1934.

TABLE 1

Galloway and Holstein parent cattle

(a) GALLOWAY CATTLE

Alaskan herd no.	Name	Reg. no.
	Cows	
10	Mollie C. of Red Cloud	25239
71	Mollie 3rd of Kodiak	34911
123	Miss 2nd of Kodiak	40338
140	Bertha A	34889
147	Hattie B	32416
187	Fidelia 4th of Kodiak	40335
209	Lady May of Kodiak	41738
215	Fidelia 6th of Kodiak	41730
246	Maggie of Kodiak	45143
247	True Beauty 3rd of Kodiak	45138
252	Mollie 8th of Kodiak	45146
277	Jaynes Banshee	48193
293	Miss of Red Cloud's Girl	48148
	Bulls	
163	Carnot of Kodiak	39139
218	Prince Douglas 3rd of Kodiak	45136
303	Ranger of Seven Oaks	45044
329	Aberdeen	2646*

(b) HOLSTEIN CATTLE

	Cows	
2H	Cascade Betsy	154663
3H	Cascade Betsy 2nd	260870
4H	Miss Gladys Cornucopia	336455
5H	Grandview Fayne Piebe Johana	233446
6H	Gladys Mercedes Banks	336456
9H	Gladys Mercedes Banks 2nd	596282
13H	Kodiak Mercedes Banks	596283
16H	Betsy Chimacum Cornucopia	692342
25H	Miss Gladys Shadford	963107
	Bulls	
1H	Chimacum Sir Quirinus Cornucopia	176468
7H	Islander (Eligible to registry)	
20H	Shadford Segis Hartog 2nd	352564
35H	Heilo Pontiac King	519811

* Canadian herd book registry

days. The longest gestation for a male was 293 days, and the longest period of gestation for a female was 299 days.

The reports of several investigators indicate that there is a variation in the gestation period for the different breeds of cattle. Wing (1912) reported that from a mixed herd of Jersey and Holstein calves, 182 calves averaged 280 days of gestation. The shortest was 264 days and the longest 292 days, and the period was approximately the same for both sexes. Wellman (1910) reported 288 Hungarian cows carried their calves an average of 284.61 days and 291 Simmenthal cows carried their calves for an average of 291.2 days.

TABLE 1a

Twenty-five reciprocal Galloway and Holstein Matings

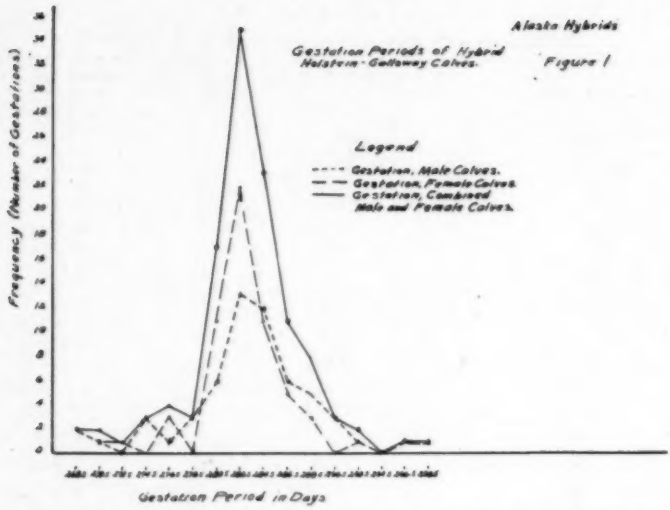
SIRE P_1	DAM P_1	OFFSPRING F_1
Galloway	*Holstein*	
Herd No.	Herd No.	
163	5H	♀ 5
218	5H	♂ 8
163	3H	♂ 6
303	6H	♀ 14
303	9H	♂ 15
303	2H	♂ 22
303	4H	♀ 30
303	13H	♂ 40
329	25H	♀ 52
329	16H	♂ 66
Holstein	*Galloway*	
Herd No.	Herd No.	Herd No.
1H	71	♀ 1
1H	147	♂ 2
1H	187	♀ 3
1H	10	♀ 4
1H	246	♂ 7
1H	247	♂ 11
1H	277	♀ 16
1H	209	♂ 17
1H	293	♀ 18
1H	215	♂ 19
1H	123	♂ 20
1H	140	♀ 21
20H	215	♀ 28
1H	252	♂ 33
20H	246	♀ 39

♀ Female.
♂ Male.

McCandlish (1922) in a summary based upon 369 gestations found a mean of 280 days in the dairy herd at the Iowa State College. McCandlish decided that the length of gestation was not affected by sex of the calf, breed or age of the cow, or season of freshing. Contrary to McCandlish's findings, Fitch, McGilliard, and Drumm (1924) found a difference in length of gestation between the breeds at the Kansas Station as follows:

Average gestation for Jerseys ..... 284.3 days
Average gestation for Guernseys ..... 283.0 days
Average gestation for Ayrshires ..... 284.6 days
Average gestation for Holsteins ..... 281.0 days

Copeland (1930) studying Jersey cattle, found an average gestation of 278.5 days for 1,075 Jersey cows. His data showed that males were carried an average of one day longer than females. Hooper and Nutter (1924) reported that 59 per cent of the calves dropped by 44 cows that carried their calves more than 280 days were males.



The data obtained upon the average length of gestation for the Alaska hybrids agree closely with the generally accepted average of 283 days for cattle. (Henry and Morrison, 1923, and Dawson, 1925.) No significant difference was noted between the gestation periods for the calves of the first four generations of hybrids. The one and only male of the fifth generation was carried in gestation 287 days (Table 2).

TABLE 2

Gestation period of Holstein-Galloway hybrids

SEX AND GENERATION	AVERAGE GESTATION PERIOD (DAYS)
13, F_1 hybrid males	284.7
12, F_1 hybrid females	283.9
21, F_2 hybrid males	281.2
19, F_2 hybrid females	282.5
16, F_3 hybrid males	281.8
24, F_3 hybrid females	283.2
4, F_4 hybrid males	284.2
6, F_4 hybrid females	286.6
1, F_5 hybrid males	287.0

BIRTH-WEIGHT OF HYBRID GALLOWAY-HOLSTEIN CALVES

The birth-weight of calves has been reported upon by several investigators. Dvorachek and Semple (1931) report an average birth-weight of 64.2 pounds for 21 Arkansas native calves, and 66.9 pounds for 21 purebred Aberdeen Angus calves, and 61.5 pounds for 20 crossbred calves.

When the first crossbred females were backcrossed to purebred Angus, 23 hybrid calves were produced which weighed 65.9 pounds.

In a study of a number of breeds, Eckles (1919) records the birth-weights of the University of Missouri herd calves as follows:

BREED	NO. CALVES BOTH SEXES	AVERAGE WEIGHT
Jerseys	196	55.0 lbs.
Holsteins	154	90.0 lbs.
Ayrshires	53	69.0 lbs.
Dairy Shorthorns	30	73.0 lbs.

From miscellaneous data compiled by Eckles:

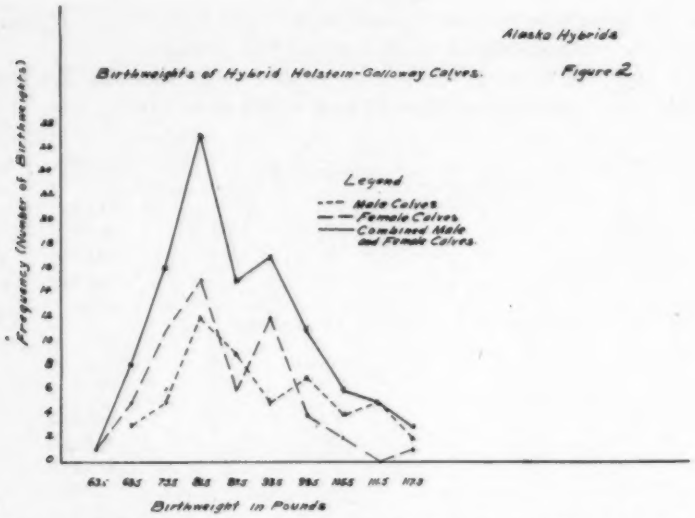
BREED	NO. CALVES BOTH SEXES	AVERAGE WEIGHT
Jerseys	253	55.0 lbs.
Holsteins	229	89.0 lbs.
Guernseys	57	57.0 lbs.
Ayrshires	80	76.0 lbs.
Brown Swiss	5	100.0 lbs.

Hulse and Nevens (1917) report considerably heavier average birth-weights for Jersey and Guernsey calves, and approximately the same weight for Holstein and Ayshire calves; the weights were 88 pounds for female Holstein calves and 90 pounds for male Holstein calves. The number of individuals was not given.

Comparing the average birth-weights of the Alaska Agricultural Experiment Station hybrids, 87.9 ± 8.2 pounds, with the average birth-weights given by Eckles and Hulse and Nevens, it appears that Holstein calves average slightly heavier at birth than the Galloway-Holstein hybrids. Eckles states that cows between the ages of five and ten years produce the maximum sized calves. Most of the calves studied in the Alaska experiment were from dams three to six years of age.

Birth-weights were obtained for 109 of the 116 hybrids. The average birth-weight for the 109 hybrids was 87.9 ± 8.2 pounds (fig. 2). The range of the probable error indicates that the birth-weights of half of the calves were between 78.6 and 96.1 pounds. Fifty-two were males averaging 91.0 ± 8.7 pounds, and 57 were females averaging 85.0 ± 7.2 pounds. There seems to be no significant difference in birth-weight between the males and females of this investigation.

The birth-weights of 106 individuals were correlated with their gestation periods. These showed a positive correlation of 0.183, which is taken to indicate that for the calves of this experiment there exists little or no relationship between weight at birth and number of days carried in gestation.



The average birth-weights of each of the four generations were as follows:

21 F_1 hybrids, both sexes averaged 87.7 lbs. at birth
36 F_2 hybrids, both sexes averaged 82.4 lbs. at birth
38 F_3 hybrids, both sexes averaged 90.6 lbs. at birth
10 F_4 hybrids, both sexes averaged 85.6 lbs. at birth

Forty-eight individuals, 47.9 per cent of which were males, progeny of hybrid F_1 bulls (Nos. 6, 33, and 66) and hybrid cows, averaged 85.7 pounds at birth. Thirty individuals of which 46.6 per cent were males, progeny of the F_2 bulls (Nos. 46 and 69) and hybrid cows, averaged 94.0 pounds at birth. The figures indicate a possible increase in the birth-weight of progeny of hybrid F_2 bulls over the birth-weight of the progeny of hybrid F_1 bulls. Further investigation, however, is necessary to establish the point.

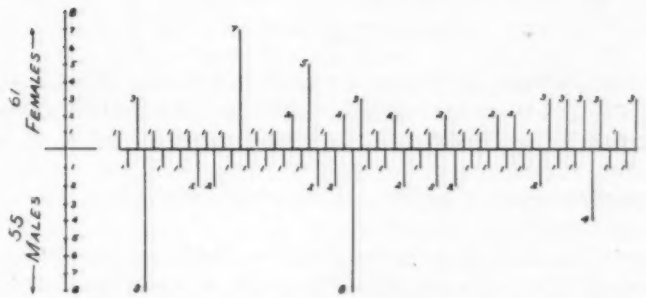
PROPORTION OF THE SEXES

Sixty-one head, 52.1 per cent, of the 116 hybrids thus far obtained have been females. For the relatively small number of animals the percentage agrees rather closely with findings of other investigators that the proportion of males to females in a population is approximately 1:1 (Wright, 1920). The ratio is due to chance sorting when a large number of animals is considered. Figure 3 shows in graphic form, the order of occurence of the males and females for the 116 hybrids being studied. From this graph it appears that sex is due to chance sorting (Rommel, 1920). A preponderance of either sex might be shown by taking an accounting at a particular

ALASKA HYBRIDS

ORDER OF BIRTH BY SEXES FOR HYBRID HOLSTEIN-GALLOWAY CALVES.

Figure 3



time. In the first 24 births, 15 were females and 9 were females, while if the first 52 animals are considered, 24 were males and 28 were females. A tabulation of the sex of the progeny of Holstein, Galloway, and hybrid bulls, is shown in Table 3. For the numbers dealt with it is believed that no significance should be attached to the preponderance of one sex or the other as they are related to individuals in Table 3. No particular signifi-

TABLE 3

Sex of progeny of bulls, showing totals for breeds and individuals

BULL HERD NO.	SIRE	DAM	OFFSPRING	
			Male	Female
1H	Holstein	13 Galloway	7	6
7H	Holstein	1 Galloway	1	0
20H	Holstein	8 Galloway	2	6
35H	Holstein	1 Galloway	1	0
			12	12
163	Galloway	2 Holstein	1	1
218	Galloway	1 Holstein	1	0
303	Galloway	7 Holstein	5	2
329	Galloway	2 Holstein	1	1
			8	4
6GH	F_1 Hybrid	9 Hybrid	3	6
33GH	F_1 Hybrid	32 Hybrid	18	14
66GH	F_1 Hybrid	8 Hybrid	2	6
46GH	F_2 Hybrid	28 Hybrid	10	18
69GH	F_2 Hybrid	4 Hybrid	3	1
			36	45
			55	61

cance can be attached to the excessive number of females in the relatively small number of animals in this experiment, due to breed, or to individual bulls. This is of interest in view of the assertion often made by laymen and others relative to the effect upon the sex ratio of calves due to age, breed, or physical condition of the bulls.

SUMMARY

The average gestation period for 116 Holstein-Galloway hybrid calves was 282.9 days. There was no significant difference between the average gestation period of the females and the average gestation period of the males.

The average birth-weight for 109 hybrids composed of 52 males and 57 females was 87.9 pounds.

The males averaged 91.0 pounds at birth and the females 85.0 pounds.

The proportion of sexes for 116 Holstein-Galloway hybrids was 61 females to 55 males which is not statistically significant. The proportion of sexes varied in both directions when the ratios were determined with random numbers of the less than 116 head.

REFERENCES

COPELAND, LYNN. Length of gestation in Jersey cows. JOURNAL OF DAIRY SCIENCE 13: 257–265. 1930.

DAWSON, J. R. Care and management of dairy bulls. Farmers' Bul. 1412. Pp. 10–16. U. S. D. A. 1928.

DVORACHEK, H. E., and SEMPLE, A. T. Beef producing qualities of purebred Aberdeen Angus cattle compared with Arkansas native cattle. Arkansas Bul. 247. Pp. 9–12. 1931.

ECKLES, E. H. A study of the birth-weight of calves. Univ. of Mo. Research Bul. 35. Pp. 5–6. 1919.

FITCH, J. B., MCGILLIARD, P. C., and DRUMM, G. M. A study of the birth-weight and gestation of dairy animals. JOUR. OF DAIRY SCIENCE 7: 222. 1924.

HENRY, W. A., and MORRISON, F. B. Feeds and feeding, 18th ed. The Henry-Morrison Co., Madison, Wisconsin. P. 408. 1933.

HOOPER, J. J., and NUTTER, J. W. Sex of overtime calves. Jour. Heredity 15: No. 11. November, 1924.

HULSE, R. S., and NEVENS, W. B. Feed and care of the dairy calf. Ill. Sta. Circ. 202. 13 p. 1917.

MCCANDLISH, A. A. Studies in the growth and nutrition of dairy calves. JOUR. OF DAIRY SCIENCE 5: 301. 1922.

ROMMEL, GEORGE M. Essentials of animal breeding. Farmers' Bul. 1167. P. 6. U.S.D.A. 1920.

WELLMAN, O. The deviation of the length of gestation period according to the season of the year. Landw. Jahrb. 39: 409–428 (No. 3). 1910.

WING, H. H. The period of gestation in cows. Cornell Sta. Bul. 162: 227–233. 1912.

WRIGHT, SEWELL. Principles of livestock breeding. U.S.D.A. Bul. 905. P. 7. Revised July, 1923.

METHODS FOR TESTING FROZEN CREAM[1]

H. C. TRELOGAN AND W. B. COMBS
University of Minnesota, St. Paul, Minnesota

The fact that no accurate, dependable method for sampling and testing frozen cream is available has been the source of much controversy which has tended to hold back the development of this phase of the dairy industry. The common trade practice of standardizing cream prior to freezing slightly below the specified fat content of the frozen product may be explained by this lack of a dependable test. Ice cream manufacturers who use frozen cream as a source of butterfat for standardizing mixes are particularly embarrassed when they do not know the exact fat content of the frozen cream. Some large buyers have demanded that their representatives be permitted to sample and test the cream before it is frozen. Such a procedure is obviously expensive and a suitable test would be an advantage both to the buyer and legitimate shippers. This work has been conducted to study the reliability of two methods for testing frozen cream.

Studies concerning the fat rising in cream (1) have shown that the fat rising in creams testing 30 to 40 per cent of fat is so slight that it should be possible to freeze such creams almost homogeneously with the methods commonly practiced in the industry. In other words, if the cream is completely frozen or even partially frozen within 24 hours after pasteurization or separation there should be no significant difference, due to fat rising, between the test of the sample taken from the top of the frozen cream and the test of the sample from the original unfrozen cream. On the other hand, with cream of low fat content, about 20 per cent, the rise of fat was found to be so great that it hardly seems possible for such cream to be frozen under the present system of freezing without having the fat rising to such an extent that the product would be decidedly heterogeneous.

Baldwin (2) suggested that the butterfat content of a can of frozen cream could be determined by testing a sample that was chipped out of the top of the can. He secured results indicating that cream containing more than 30 per cent butterfat tended to freeze homogeneously and such cream could be accurately analyzed for fat by taking a sample from any part of the unfrozen or frozen portion. Baldwin also suggested possibilities for testing frozen cream by weighing the sample directly into the test bottle before it melted. Inasmuch as practically all cream that is frozen com-

Received for publication June 14, 1934.

[1] The data upon which this paper is based were taken from a thesis presented by H. C. Trelogan in partial fulfillment of the requirements for the degree of M.S., University of Minnesota.

Paper No. 1281 Journal series, Minnesota Agricultural Experiment Station.

mercially is reputed to contain 40 per cent or more of butterfat, these testing possibilities merit an investigation of their adaptability in the industry.

EXPERIMENTAL

Preparation of Cream

In order to secure results directly applicable to the conditions in the industry, arrangements were made with a local creamery organization to carry out the experiment with cream frozen in their plant during the regular routine of their work.

Sweet cream was gathered daily from points within 60 miles and hauled by truck to the plant where it was processed and put into cold storage the same day that it was received. Upon its arrival at the plant the cream was weighed and dumped into pasteurizing vats where it was standardized, then pasteurized at 150° F. for 30 minutes. As soon as the holding period for pasteurization was completed the cream was passed over a surface cooler which reduced the temperature to about 43° F. From the cooler it was poured directly into five-gallon tin cans (lard cans) that had been previously steamed. Forty-five pounds of cream were weighed into each can in such a way as to reduce foaming to a minimum. The cans were then covered with tin lids, wired shut, and placed in cold storage at about – 24° F.

Each batch of cream consisted of 6,000 to 7,000 pounds, standardized with skimmilk, to approximately 40 per cent butterfat. The titratable acidity of the cream was usually between 0.11 and 0.13 per cent.

Sampling of Original Cream

Samples were taken from eighty cans selected at random from eleven batches of the cream and used for this experiment. These samples were obtained with a dipper, directly after the cans were filled at the cooler, and placed in half-pint bottles that were sealed and put into a cold room maintained at 40° F. until the next day, when they were tested. Preliminary experiments indicated that the accuracy of the test was not reduced by the use of the dipper method of sampling as the butterfat was evenly distributed throughout the can.

The tests from each can were recorded and the data saved for comparison with the tests secured several months later from the frozen cream.

Sampling of Frozen Cream

Three sampling methods for the frozen cream were considered. The use of an auger to bore a sample out of the can of frozen cream was first suggested. This method proved impractical, because the auger tended to churn the cream sample.

The method suggested by Bird and Johnson (3) for sampling ice cream while frozen was tried on frozen cream. These workers took ice cream samples by removing the ice cream from the hardening rooms and letting

it stand at room temperature until it became sufficiently soft to permit a cork borer to penetrate it. Plugs aggregating 4.5 to 5.5 grams were taken with the cork borer and used for samples. When this method was applied to frozen cream the cork borers were found to be too weak for penetration until the frozen cream was melted to such an extent that definite water and fat separation was taken place. However, a cork borer was prepared with saw teeth filed around the bottom so that it could be worked into the frozen cream by turning it around while pressure was applied to the handle. The saw-toothed borer was quite successful for taking small samples and could be adapted to Mojonnier tests.

The sampling method which proved to be best suited for this experiment consisted of chipping fragments of frozen cream out of the top of the can with a small screw driver. There was always a thin layer of snow or frost present on top of the frozen cream and this had to be scraped aside before the sample was taken because the frost layer did not test the same as the cream. This frost came from the moisture which condensed from the air between the top of the cream and the lid of the can. Any foam which had remained on the cream when it was placed in cold storage was scraped away with the frost layer. Sufficient chips were removed from the cream to almost fill a half pint milk bottle without packing them. The sample bottles were pre-cooled so that the chips would remain frozen until they were weighed for analysis.

Testing Frozen Samples

Two methods for handling the frozen cream sample for testing were studied. In one case the sample was weighed into the cream test bottle while it was frozen. This method will be called the "frozen test" when reference is made to it. In the other case, the sample was melted and an attempt was made to pipette the melted cream in the same manner as one would handle normal cream. This method will be referred to as the "melted test."

"Frozen Test"

It was not practical to pulverize the frozen chips to the extent that they could be weighed directly into the neck of the Babcock cream test bottle. Therefore, funnels were placed in the cream test bottles before the bottles were balanced. These funnels had long round tops and resembled a 17.6 ml. pipette with the bottom cut off and the top extending into the neck of the test bottle. The chips of frozen cream were broken with a pair of dividers or forceps into pieces of such size that they would drop conveniently into the top or bulged part of the funnel. Nine grams of frozen cream were weighed into each funnel, which, incidentlly, was about filled when the cream was slightly packed down. After the cream was weighed into the funnels the bottles were permitted to stand until the cream had melted to some extent, then 10 ml. of hot water (140°–160° F.), measured

in a pipette, was poured into the funnel in such a manner as to melt the cream remaining frozen and to rinse out the funnel, so that all of the butterfat was washed into the cream test bottle. Next the acid was added by pouring it through the funnel which thereby received another rinsing. Fifteen millilitters of acid were used. The funnels were then removed from the test bottles and the remainder of the cream test carried out according to the usual Babcock method. Excellent tests were secured when a reasonable amount of care was exercised in running them.

"Melted Test"

The melted test was carried out by melting the frozen chips remaining in the sample bottle. Specific difficulties were encountered in attempts to melt these samples. At room temperatures it took too long for the cream to melt to a point where it could be pipetted. Even when the cream was totally melted at room temperatures or at 40° F. there was such a distinct separation of the plasma from the lumpy, fat portion that it was almost impossible to get the two portions mixed together again without churning the fat. In fact, small lumps in the fat never disappeared to the extent that they did not interfere in transferring the cream with a pipette. Melting the cream with hot water soon proved impractical because the fat "oiled off" and could not be mixed into the cream again so that a representative sample could be secured in a pipette. Experimentation showed that the best method for melting the cream was to place the sample bottles in a water bath maintained at 90° to 110° F. and to agitate the bottle periodically in order to prevent "oiling off" of the fat and separation of the fat and separation of the plasma. Care had to be taken not to agitate the melted cream excessively for churning took place rather easily, and when the sample was once churned, accurate sampling was difficult. The melted samples were handled according and the cream was tested in the same manner as normal cream.

Thirty-nine of the cans placed in storage were tested and the results compared with the tests of the original cream before freezing. All of the tests were made in duplicate and reported as such with a few exceptions where accidents prevented.

Experimental Results

The average percentage of fat obtained from the tests performed on the 39 cans were:

Original	"Frozen"	"Melted"	Difference between duplicates		
			Original	"Frozen"	"Melted"
39.0769	38.6410	38.5820	0.128	0.467	0.767
Difference between Original and "Frozen"			Difference between Original and Melted		
	−0.419			−0.457	

Analysis of Results

A general analysis of these data shows that the average or the mean test of the original samples was 39.0769 per cent; of the frozen samples, 38.6410 per cent; and of the melted samples, 38.5820 per cent. This would give the impression that the frozen samples and the melted samples tested less than the original samples, but before such an assumption can be made some factors that are involved must be considered. First, it was noticed that there was a definite difference between the duplicate tests of the same samples even in the original tests. Second, some of the tests of the frozen samples were higher than the original tests of the same samples. Six of the 39 cans tested by the "frozen" method did not give results within one per cent of the original test. Subsequent check tests proved that in three of these cases the larger differences were probably due to faulty technique in conducting the test. These check tests have also given evidence that the results for the three other cans were influenced by some factors related to the freezing conditions that were not involved in the test itself. Therefore, it was considered logical to omit the data for these three cans when discussing the merits of the "frozen" and "melted" tests.

In seventeen cases, the "frozen" tests gave higher results than the original tests of the same cream, and in nineteen cases the results were lower. The "melted" tests gave higher results in nineteen cases and lower results in fourteen cases.

Statistical Analysis

The means and standard error of the means of the three testing methods for 36 cans were found to be as follows:

Original test	$39.0814 \pm .0150$
"Frozen" test	$39.1422 \pm .1359$
"Melted" test	$39.2928 \pm .2506$

This indicates that 95 out of every 100 means of similar cream samples tested by the Babcock method may be expected to test within the range of 39.0514 per cent and 39.1114 per cent; 95 out of every 100 similar means obtained by the "frozen" method may be expected to test between 38.8904 and 39.4140 per cent; and 95 out of every 100 tested by the melted method may be expected to test between 38.7916 and 39.7940 per cent. It is evident from these results that the mean of the "frozen" test is more reliable than the mean of the "melted" test.

Similarly this was found to be true by determining the standard error of the mean of the differences in the results secured by the "frozen" and "melted" tests in comparison with the original Babcock test. The mean of the differences for the "frozen" test is 0.0875 and the standard error of the mean of the differences is $\pm$ 0.0963. The mean of the differences for the "melted" test is 0.2728 and the standard error is $\pm$ 0.2189. The standard deviations of these two sets of differences are 0.5781 and 1.2384 respectively.

Practical Application of Data

A practical interpretation of the statistical analysis would mean that any dealer, who is buying frozen cream which is supposed to contain approximately 40 per cent or more of butterfat, may check the butterfat content to the best advantage with the "frozen" test. The results indicate that if he tested as many as six cans by this method he could safely consider his average reliable within a range of 0.5 per cent of the Babcock test of the original cream. However, in case only a single can is tested, there is one chance out of four that the difference will exceed the 0.5 per cent range. If the buyer were to use the "melted" test for checking the butterfat content of the frozen cream, an average of duplicate tests on six cans could reasonably be considered within one per cent of the test of the original cream.

Inasmuch as the check tests that can be secured by the "frozen" method are more accurate and reliable than those obtained by the "melted" method, and inasmuch as the "frozen" method is more convenient to conduct in the laboratory, it is to be recommended as the best way to test frozen cream.

Summary and Conclusions

The reliability of two methods for testing frozen cream was studied by testing 36 cans of such cream and making a statistical analysis of the results obtained. The "frozen" test, performed by weighing frozen chips of cream from the top of the can directly into the test bottle, gave results which indicated that the average of six duplicate analyses was reliable within 0.5 per cent of the test of the original cream. The melted test, secured after melting the chips of frozen cream, gave results that were reliable within 1.0 per cent of the test of the original cream, when the average of six cans was used.

The "frozen" test is recommended for the butterfat analysis of frozen cream.

ACKNOWLEDGMENT

The writers wish to acknowledge the cooperation of the Land O'Lakes Creameries Association in permitting us to use the facilities of their plant and laboratory in the pursuance of this problem.

REFERENCES

(1) TRELOGAN, H. C., AND COMBS, W. B. Fat Rising in Cream. JOURNAL OF DAIRY SCIENCE. 1934.

(2) BALDWIN, F. B. Frozen milk and cream investigations. Master of Science Thesis, University of Minnesota. 1932.

(3) BIRD, E. W., AND JOHNSON, E. A. The effect of processing, handling and testing procedures on the fat content of ice cream. Ia. Agr. Expt. Sta. Bul. 287: 365. 1931.

CERTAIN FOAM PRODUCING SUBSTANCES OF MILK*

S. ANSBACHER, G. E. FLANIGAN, AND G. C. SUPPLEE

The Dry Milk Company, Inc., Research Laboratories, Bainbridge, New York

One of the fundamental laws which govern the formation of foam is that of Gibbs and Thomson, which teaches that all matter diminishing the surface tension of water assembles at the surface. Siedel and Hesse (1) presented analytical data showing that the foam of skimmed milk contains more protein matter than the body of the milk from which the foam had been produced. This observation has since been confirmed by others and it may be assumed therefore that the capillary-active substances of milk are nitrogenous in character. Siedel (2), Hekma and Brouwer (3) have presented evidence indicating that the protein matter of skimmed milk foam is neither casein nor lactalbumin. Grimmer and Schwarz (4) based an investigation of the foam producing substances of milk upon analytical studies of separator slime and found that this material contained 36 per cent of casein and 64 per cent of proteinaceous matter other than casein or lactalbumin. Rahn and Sharp (5) state that this proteinaceous matter is probably identical with the foam producing material of milk which they designate as "Schaumstoff."

Observations made in these Laboratories during the past decade have focused attention on the character of the foam producing substances of milk. That such material is proteinaceous in nature, although not typical of either casein or lactalbumin, has been indicated on numerous occasions during the course of investigations not particularly pertinent to the subject. Certain caseins, lactalbumins, milk sugar liquors, and other integrated milk constituents have been noted to possess unpredictable foaming properties. These observations seemed to warrant further study of the capillary-active substances involved in milk foam. Such a study might in all probability contribute to a better understanding of such practical problems as foaming casein, creaming of milk, cream body, insolubility of milk powders, as well as other problems with which the milk industry is concerned.

EXPERIMENTAL

Numerous observations seem to support the view that the foam producing material exists in a highly dispersed state in milk. Therefore quantitative recovery presents certain difficulties; however, such material may be

Received for publication July 9, 1934.

* Presented at the 29th Annual Meeting of The American Dairy Science Association, June 27, 1934, Ithaca, N. Y.

obtained in part from certain milk constituents with which it is associated, as for example, casein.

Certain commercial caseins possessing a high foaming tendency were eluted with dilute sodium chloride solution at appropriate hydrogen-ion concentrations. The eluted casein no longer possessed any substantial foaming ability whereas the elution product showed remarkable foaming properties. Approximately 100 cc. of freshly prepared product containing only a few milligrams of organic matter permitted the formation of a permanent foam volume of nearly 4 cubic feet. It is this elution product which served as a basic material for the studies reported hereinafter. The material as obtained was a clear, colorless liquid containing 0.072 per cent solids other than salts. Its nitrogen, phosphorus and sulfur content calculated to the dry, salt-free basis was 13.64 per cent, 0.72 per cent, and 0.60 per cent, respectively.

Surface tension measurements were made with a Du Noüy Precision Tensiometer (6). The results of the determinations made with the fresh material and after various treatments are shown in Table 1, from which it will be noted that the surface-activity is substantially the same as that of skimmed milk. Under the influence of heat the surface tension increased slightly but measurably. A similar increase is reported by Dahlberg and Hening (7) for skimmed milk as a consequence of pasteurization.

TABLE 1

Surface tension of the elution product of casein

TREATMENT OF SAMPLE	TOTAL SOLIDS (MG. PER 100 CC.)	MINUTES BEFORE READING	SURFACE TENSION AT 25° (DYNES PER CM.)
None	72	2	51.6
None	72	10	52.0
None	72	30	52.0
None	72	120	50.2
None	72	240	50.9
Boiled	72	2	56.2
Concentrated at 50° and rediluted	72	2	54.2
Irradiated*	72	2	53.2
Diluted with water (1: 5)	14	2	54.9
Diluted with water (1: 5) and boiled	14	2	57.6
Diluted with water (1: 100)	0.72	2	59.0
Diluted with water (1: 1000)	0.072	2	63.6
Diluted with water (1: 5000)	0.014	2	75.1

* Irradiated with a quartz mercury vapor lamp at 18 inches distance for 30 minutes.

The presence of substances in a colloidal state was further revealed by other general characteristics of the product. When exposed to a temperature of 23° C. or above a turbidity developed and slowly increased in intensity. When such warmed material was cooled slowly over a period of hours and allowed to remain at temperatures between 1 and 10°, the turbidity disappeared and a water clear or substantially water clear solution again resulted. Successive alternate warmings and coolings could be carried out for 3 to 4 times, providing the temperature was not raised too high, with visible evidence of increase in turbidity at the higher temperature and subsequent clearing of the solution at the lower temperature. However, upon successive changes in temperature the turbidity became more and more stable, ultimately resulting in a permanent cloudiness and settling out of a precipitate. Still further evidence of the unstable character of the material was manifested by the fact that on long standing in the absence of light and at relatively low temperatures turbidity developed and a precipitate formed. During the first 3 days the pH of the material shifted from 4.2 to 5.8 at which point it remained constant for many months. The constancy of the pH of the aged sample is in all probability due to the gradual insolubilization of a substance, the isoelectric point of which is, under the particular conditions, pH 5.8. Adjustment of the acidity of fresh samples and of slightly turbid samples to pH 5.8 yielded a flocculent precipitate further confirming the presence of a substance which has its isoelectric point at pH 5.8.

The above observations are interpreted to mean that a degree of supersaturation exists in the solution. The term "supersaturation" is used here in accordance with the hypothesis advanced by Schade (8). There seems to be a zone of abnormal retention of supersaturation. Any factor which will alter the conditions of supersaturation will furnish the impulse for a change from the supersaturated state of the colloid to a less dispersed state, resulting ultimately in the agglomeration of the material. Such impulses may be furnished by agitation, light, change in the hydrogen-ion concentration and raising of the temperature.

As stated above, 23° was found to be the temperature at which visible agglomeration became evident. This observation is significant, since curves for the foaming ability of milk and cream at various temperatures show a kink between 20 and 30° (9). Furthermore the curves reported by Rahn and Sharp (10) for the foam height of skimmed milk at various temperatures show a similar characteristic within the same temperature range. These authors raise the question whether these kinks indicate the presence of a specific foam producing material or of a stabilizing substance in the foam. In view of the properties shown by the material discussed in this paper it appears that the observations noted by other investigators may be due to the substance which exhibits a critical agglomeration at 23°.

The agglomerate, even after drying at room temperature, is of a vitreous or resinous character only slightly soluble in water. The clear solution of the original material showing no visible evidence of agglomeration, when dried in a dispersed state at room temperature, as in the drying of foam, was more readily dispersed in water, although not entirely so. However, if this dry dispersed material was compacted in the presence of even only a slight amount of moisture, it showed the same relative insolubility as the dried agglomerate. The agglomerate freed from electrolytes as far as possible was soluble in water after prolonged boiling to the extent of only 40 mg. per 100 cc. Such a solution showed a surface tension of 51.6 dynes per cm. which is equal to that of the original freshly obtained product.

In view of the generally accepted opinion that nitrogenous matter concentrates in the foam, quantitative removal of the material contributing to the formation of foam was attempted by whipping. An appropriate amount (about 500 cc.) of the original material was whipped by suitable means. The foam thus obtained was removed from the surface of the liquid with a minimum of compaction and allowed to drain on a wire screen. The remaining liquor was combined with that which had drained from the foam. The slightly turbid mixture was again whipped and the foam was removed as above. The less turbid liquid now obtained was again whipped but yielded only a very small amount of a relatively unstable foam. The liquid remaining after the removal of the foam showed no evidence of turbidity. Analytical data were obtained for the dried foams and the remaining liquids. The results are shown in table 2 from which it is to be noted that as the foam is removed the nitrogen and phosphorus content of the remaining liquid becomes less and less. The entire process approaches a quantitative removal of nitrogen and phosphorus. The liquid after practically complete removal of nitrogen and phosphorus still possessed capillary-activity and showed a surface tension of 61.9 dynes per cm.

TABLE 2

Nitrogen and phosphorus content of the elution product of casein, foam and residual liquid

DESCRIPTION OF MATERIAL	PER CENT NITROGEN ON DRY BASIS	PER CENT PHOSPHORUS ON DRY BASIS
Original	4.35	0.09
First Foam	10.93	0.31
First Liquid	2.30	0.06
Second Foam	9.19	0.22
Second Liquid	0.92	0.04
Third Liquid	0.75	Trace

The phosphorus of the original as well as of the foam samples was not true inorganic phosphorus. Other data obtained with similar foam products have always shown phosphorus in organic combination in amounts varying between about 0.2 per cent and 1.8 per cent on the dry basis. Likewise cholesterol was found to be present in all foam producing solutions according to qualitative tests. The presence of phosphorus in organic combination and of cholesterol should not be lost sight of in any technical study of the foam producing substances of milk. Sulfur has also been found in all such material and it is significant that the material contained no cystine.

Since there is ample evidence indicating an interrelationship between the substances contributing to the formation of foam, the churning of butter, viscosity, as well as other physical characteristics of cream and various milk mixtures, it seemed desirable to ascertain by simple and direct experimentation, whether the material under investigation could be shown to influence certain of these phenomena. Inasmuch as considerable speculation has been advanced concerning the factors affecting the cream layer of milk and the body of cream, the elution product with which we are concerned was added to whole milk in minute quantities for the purpose of determining its effect upon the depth of the cream layer.

Five cc. portions of the material, containing only 0.072 per cent solids other than salts, were added to 200 cc. portions of fresh fluid whole milk. After mild agitation 10 cc. portions of the mixture were transferred to graduated tubes and the cream allowed to rise during periods of 24 and 48 hours. The effect upon the cream volume is shown in the accompanying table 3. An increase in cream volume was noted in all cases. Equivalent results were obtained with other samples similarly treated, the data recorded being only a summary of numerous observations. It will be noted that the material added to sample 2 was in a more highly dispersed state than that used for the other samples and that it caused the greatest increase in cream volume. There was a reduction in effectiveness of the added material caused by heat, aging, and light. It is apparent that the increased cream volume is due primarily to the physical state in which the material exists rather than to the gross quantity added; only 1.8 mg. of active solids were mixed with 100 cc. of whole milk. Viscosity of the solution added could not have been a contributing factor, because measurements were made with a Sabolt Viscosimeter and showed values identical with that of water within a temperature range of 12 to 65°.

The instability of the material under the influence of heat, agitation, and aging was likewise manifested by exposure to ultra-violet rays. When exposed to the rays of a quartz mercury vapor lamp for sufficient length of time an odor developed resembling somewhat that of over-irradiated milk, but more particularly that which results from exposure of human skin to strong ultra-violet light. This suggests the mobilization of SH-

bodies, as observed by Wels (11). The aged material also gave off the same characteristic odor during mild agitation at room temperature even though exposed to only diffused natural light.

TABLE 3

Cream volume of milk as affected by the elution product of casein

SAMPLE NO.	MATERIAL ADDED TO 200 CC. OF MILK	DESCRIPTION	CREAM VOLUME IN 10 CC. OF MILK AFTER		PER CENT INCREASE IN CREAM VOLUME
			24 HRS.	48 HRS.	
			cc.	cc.	
1	5 cc. water.		1.6	1.6	0
2	5 cc. elution product 24 days old, filtered.	Practically clear	2.4	2.6	62
3	5 cc. same as No. 2 but decanted immediately above the precipitated agglomerate.	Slightly turbid	2	2	25
4	5 cc. same as No. 2 but boiled.	Turbid	2	2	25
5	5 cc. same as No. 2 but irradiated.*	Slightly turbid	2	2	25

* Irradiated at 18 inches from a quartz mercury vapor lamp in 0.2 mm. layer for 15 seconds.

These observations indicate that the excitation by ultra-violet rays, by heat, or by agitation may affect the sulfur containing constituents of the material under investigation. From a strictly physical point of view such a common effect is not impossible, because heat, agitation, and radiant energy are essentially common forms of energy insofar as their ability to interfere with the Brownian movement of the molecules is concerned. This conception of the influence of these physical forces is further emphasized by various observations noted with the material, such as an odor characteristic of that of boiled milk noted during concentration at low temperature, after long standing at room temperature, or as a result of successive alternate warmings and coolings. It is generally known that during the boiling of milk or even heating to only about 85°, volatile sulfur compounds are formed (12). Analytical data have shown the presence of sulfur in appreciable amounts in the material under consideration, but the analytical proof of the migration of sulfur could not be obtained due to inadequacies of the available methods for the estimation of the minute quantities involved.

Isolation of the foam producing substances by dialysis was impossible due to extreme variations in diffusability apparently caused by the unstable character of the material. Dialysis of the fresh product permitted the recovery of only a small percentage of the nitrogenous matter, whereas still less nitrogen was retained with older samples which had apparently under-

gone a chemical change under the influence of the above mentioned physical factors.

Of the numerous attempts to quantitatively recover, by precipitation, the complex of substances, contributing to the formation of foam, that with chlorine gas proved to be the most effective. The liquor from which the precipitate formed by the use of chlorine gas had been removed showed no foaming properties whatsoever. Furthermore, such liquors contained no nitrogen, or at the most only minute traces. The precipitate, after suitable removal of excess chlorine was found, when redispersed in water, to possess physical properties and a gross chemical constitution similar to that of the original solution.

Chlorine gas can be applied in a practical way for indicating even small amounts of the foam producing material. Such material associated with milk sugar in minute quantities which cannot be detected by such precipitants as acid mercuric nitrate or phosphotungstic acid, is manifested by the production of foam and turbidity upon the introduction of chlorine gas.

The foam producing material was also quantitatively recovered by precipitation with chlorine gas from various milk sera from which the casein alone, or the casein and lactalbumin, or casein, lactalbumin and lactoglobulin had been removed. The greatest yields were obtained from the residual milk substances after the removal of the fat, casein, lactalbumin, most of the calcium and phosphorus and a very large proportion of the milk sugar. Specimen products obtained from this material have shown, when redispersed in water, in low concentration a surface tension of as low as 45 dynes per cm. The material recovered from any of the above milk sera possessed characteristics similar to those recorded for the casein elution product.

SUMMARY

The various data and observations as presented would seem to show that the particular group of substances contributing to the foaming ability of milk is contained in that group of milk constituents commonly designated as the "nitrogenous extractives." Such substances are physically associated with the better classified milk constituents, particularly the proteins. The physico-chemical properties of the highly dispersed and unstable colloids contributing to the foaming property of milk and to the character of milk foam are no doubt responsible for many other physical characteristics and reactions of milk and its derivatives. The reactions manifested by these colloids under the influence of change in hydrogen-ion concentration, salt content of the medium, temperature change, agitation, radiant energy, and aging serve as a basis for assigning to this milk fraction a significant rôle in many common phenomena with which the dairy chemist and milk technologist is familiar.

It is probable that the lipid material which is associated with the milk proteins and especially with the nitrogenous colloids discussed in this paper contributes not only to the surface-active characteristics of the material with which it is prosthetically bound, but also to the other physical properties exhibited by milk and certain of its derivatives. Direct proof of the presence of a saponin-sterol grouping as a normal constituent of the surface-active substances under consideration is difficult. However, certain evidence would seem to indicate such a possibility. The precise character of the proteinaceous constituent of the material dealt with in these studies cannot be defined in terms of the usual classifications without reservation. Lactoglobulin is strongly suggested by many of its properties; however, irregularities in chemical constitution and many of its physical reactions prevent firm conclusions to this effect.

The conception of prosthetically bound entities or specific groupings which influence or in fact may determine primary reaction characteristics of specimen products such as milk and certain of its constituents, is in conformity with considerable data of recent origin. Such a concept permits an approach to many complicated problems prevalent in the milk industry which is impossible from a strictly analytical point of view. In a previous paper from these Laboratories (13) it was shown that certain biological activities exhibited by milk constituents may be due to a prosthetically bound complex involving the milk proteins, especially the lactalbumin, and cholesterol.

In considering the various observations recorded in this paper from a purely biochemical standpoint the colloidobiological study of the vitamins by von Hahn (14) should be mentioned. The author considers vitamin activity in parallel with surface-activity. The activation and inhibition of certain enzymes may be dependent upon capillary-activity, as Glick and King (15) have recently reported. In all probability digestion, assimilation, and elimination are influenced by surface-active substances. Notwithstanding the speculative possibilities concerning the relationship between the surface-active properties of milk substances and physiological matters, it is reasonably certain that such properties exhibited by segregated milk constituents indicate their potential rôle in affecting many phenomena commonly observed in the milk industry.

ACKNOWLEDGMENT

The authors acknowledge the assistance rendered by the following during the accumulation of data summarized in this paper: Miss Zaida M. Hanford, Mr. M. R. Simonds, Dr. R. C. Bender and Mr. W. J. Hendrickson of The Dry Milk Company Research Laboratories' staff; also contributions to the analytical data made by Dr. E. B. Marum and Dr. Hilda F. Wiese of the Borden Research Laboratories, Syracuse, New York.

REFERENCES

(1) SIEDEL, J., AND HESSE, A. Über das Schäumen der Milch bei der Entrahmung mittelst Centrifugen. Molkerei-Zt. Hildesheim. **14**: 637, 654. 1900.

(2) SEIDEL, J. Über einige den Butterungsvorgang betreffende Beobachtungen und eine hierauf begründete Erklärung der Butterbildung. Molkerei-Zt. Hildesheim. **16**: 505, 525. 1902.

(3) HEKMA, E., AND BROUWER, E. Over melkschuimvliesjes en de aan hunne vorming ten grondslag liggende substantie. Verslag. landb. Onderzoek. Rijkslandbouwproefsta. **28**: 46. 1923.

(4) GRIMMER, W., AND SCHWARZ, G. Zur Kenntnis des Zentrifugenschlammes. Milchwirtschaft. Forsch. **2**: 163. 1925.

(5) RAHN, O., AND SHARP, P. F. Physik der Milchwirtschaft, Berlin, 1928, p. 7.

(6) DU NOÜY, P. L. An apparatus for measuring surface tension. Jour. Gen. Physiol. **1**: 521. 1919.

(7) DAHLBERG, A. C., AND HENING, J. C. Viscosity, surface tension, and whipping properties of milk and cream. N. Y. State Agr. Exp. Sta., Bull. 113, August, 1925.

(8) SCHADE, H. Concretions. ALEXANDER, J., Colloid Chemistry. The Chem. Catalog Co., New York **2**: 803. 1928.

(9) ASSOCIATES OF ROGERS, L. A. Fundamentals of Dairy Science. The Chem. Catalog Co., New York, 172. 1928.

(10) RAHN, O., AND SHARP, P. F. Physik der Milchwirtschaft, Berlin, 1928, p. 16.

(11) WELS, P. Die Entstehung eines reversibel oxydierbaren Körpers durch Bestrahlung von Eiweiss. Arch. exptl. Path. Pharmakol. **171**: 480. 1933.

(12) PORCHER, CH. Le lait desséché. 2nd ed., Lyon, 1926, p. 81.

(13) ANSBACHER, S., AND SUPPLEE, G. C. The cholesterol content and the antirachitic activation of milk constituents. Jour. Biol. Chem. **105**: 391. 1934.

(14) v. HAHN, F.-V. Colloidobiological study of the vitamins. ALEXANDER, J., Colloid Chemistry. The Chem. Catalog. Co., New York **2**: 917. 1928.

(15) GLICK, D., AND KING, C. G. Relationships between the activation of pancreatic lipase and the surface effects of the compounds involved. The mechanism of inhibition and activation. Jour. Biol. Chem. **97**: 675. 1933.

PASTURE FERTILIZATION RESULTS

R. H. LUSH
Louisiana Agricultural Experiment Station, Baton Rouge, La.
AND
J. L. FLETCHER
Southwestern Louisiana Institute, Lafayette, La.

In the fall of 1929, pasture management trials were started at the Southwestern Louisiana Institute dairy farm, Lafayette, Louisiana. The land is rolling prairie type, slightly acid and somewhat low in fertility due to continual cropping.

Section A, consisting of eight acres that had been in silage corn in 1929, was disced thoroughly and seeded to White Dutch clover and domestic rye grass in October and lespedeza added in February. Bermuda and carpet grass have come in since then. In March nitrate and superphosphate were added singly and in combination and, even in the dry season of 1930, approximately doubled the yields of hay over check plots. In late fall one-half of these eight-acre plots was limed with two tons of calcium carbonate (crushed oyster shell) per acre. Rye grass was again seeded and the same rate of fertilization followed on each plot for the following three years. One-half of the nitrate was applied in the spring and other fertilizer in the late fall. This section was cut three times, and in 1931 four times, for hay and the yield of cured hay determined from representative areas. The average yearly hay yield from unlimed plots, regardless of fertilization, was 7,528 pounds, and for limed 8,705 pounds, or 15.6 per cent greater. The average hay yield for check plots not fertilized was 6,871 pounds. Annual application of 200 pounds nitrate of soda gave 9,861 pounds of hay, or 43.5 per cent increase. Two hundred pounds of 18 per cent superphosphate gave 8,323 pounds hay, or 21.1 per cent increase; while nitrate and superphosphate together gave 10,071 pounds hay, or 46.6 per cent increase over no fertilizer. Potash apparently had no effect on yield and the use of ammonium sulphate apparently lowered the yield 1,006 pounds, or 14.6 per cent through adverse effect on white clover.

Section B, consisting of four acres of permanent pasture, was given similar treatment except grazed and yields determined from caged areas. Here the response to fertilizer was more marked, with an average increase of 65.8 per cent for nitrate of soda and 180.5 per cent for nitrate and superphosphate. Still another similar field (E) has given 103.6 per cent increase in hay for nitrate and superphosphate during the last two years. Field C, similar to A in that it was seeded in 1929, but treated with 150 pounds of a complete fertilizer and 150 pounds cyanamid each year, aver-

Received for publication July 16, 1934.

aged 12,976 pounds hay, or 90.7 per cent increase over check plots for the past three years.

Every cutting of hay was analyzed and is expressed as percentage of dry matter, total dry matter, crude protein, and total digestible nutrients in Table 1. The effects of fertilization on composition is not as great as the seasonal difference between cuttings of hay. Liming apparently had little effect on composition.

TABLE 1

Average composition and yield of hay cut from fertilized pasture plots, Lafayette, Louisiana—1931–1933

DATE	NO.	TREATED	PER CENT OF DRY MATTER					POUNDS PER ACRE		
			Protein	Fat	N.F.E.	Fiber	Ash	Dry matter	Protein	T.D.N.
1st cutting	21	Limed	17.12	2.97	44.00	25.49	10.40	3116.13	504.30	1921.61
"	21	No lime	17.13	2.94	44.99	25.09	9.80	2373.36	408.03	1522.10
2nd cutting	21	Limed	13.75	2.11	43.96	31.54	9.71	1184.29	194.60	654.88
"	21	No lime	13.82	2.09	41.97	32.83	9.31	1129.92	196.72	632.93
3rd cutting	21	Limed	9.33	1.98	49.44	30.99	8.44	2046.88	142.04	994.38
"	21	No lime	8.58	2.09	49.33	31.47	8.42	1985.84	131.06	996.98
1st cutting	40*	Fertilized (N or P)	17.35	2.95	43.45	25.54	10.66	3545.24	589.89	2182.54
"	15	None	16.33	2.94	45.75	24.82	10.15	2037.00	310.89	1259.48
2nd cutting	40	Fertilized	14.21	2.08	42.85	31.24	9.80	1630.99	255.87	880.23
"	15	None	13.33	2.21	43.27	31.48	9.69	961.71	160.91	537.98
3rd cutting	37	Fertilized	9.46	1.98	48.44	30.55	9.52	2847.70	235.27	1412.15
"	14	None	8.75	2.25	49.29	31.17	8.54	2158.50	142.24	1073.01
All	61	1st cutting	16.70	2.94	44.62	25.42	10.30	2946.20	478.75	1816.50
All	61	2nd cutting	13.76	2.09	43.01	31.87	9.61	1425.39	224.25	778.50
All	57	3rd cutting	9.06	2.02	48.71	31.72	8.47	2556.09	197.90	1267.97
(1931) only	21	4th cutting	6.56	1.49	52.07	31.52	8.36	5205.30	341.80	2485.20
Season	40	Fertilized	13.78	2.35	44.82	29.07	10.01	8010.61	1090.65	4481.02
	15	None	12.90	2.47	46.03	29.11	9.48	5129.58	618.58	2863.84
Season	21	Limed	13.40	2.35	45.80	29.34	9.52	6347.40	841.04	3570.87
	21	No lime	13.18	2.37	45.43	29.78	9.18	5489.12	735.81	3152.01

* Plot 8 (ammonium sulphate) not included here.

GRAZING RESULTS

Plot B (and a check plot) was grazed for three summers, and C and E for the past two summers. As B and E were treated alike, the results are given together for an average of five trials. Milking Jersey cows fed grain in proportion to milk yield were used and added or taken off as growth of grass permitted.

The check pasture averaged 164 cow days, 3411.6 pounds 4 per cent corrected milk, and a feed replacement value of $18.57 per acre. The pastures treated with 200 pounds nitrate of soda and 200 pounds of superphosphate averaged 292 cow days, 6697.8 pounds 4 per cent corrected milk, and a feed replacement value of $37.76 per acre. Section C treated with a complete fertilizer and cyanamid gave an average of 359 cow-days, 9,735.2 pounds 4 per cent corrected milk and a feed replacement value of $42.52 per acre. The net value of the fertilizer under these conditions was then $19.19 and $23.95 respectively per acre. However, in checking the yields of nutrients from clipped hay against the nutrients consumed in milk production and maintenance, minus that in grain fed, it was found that approximately 46 per cent of the total available was used for production in the check lot, only 36 per cent of the nitrate and superphosphate pasture and 59 per cent from Section C. This disparity in results from the two measures used emphasizes the importance of further refinement in pasture tests.

The pH value of soils from each plot has been determined each year. The trend has been gradually toward less acidity in the limed and basic fertilized plots. The limed plots averaged a pH of 6.7, while the unlimed portions of the same plots averaged a pH of 5.9 early this year (1934).

SUMMARY

Pasture vegetation under conditions of this test responded quickly and profitably to nitrate, superphosphate, and cyanamid application. It responded more slowly to liming. Potash and ammonium sulphate was not effective.

The response was in greater growth rather than effecting composition of plants. There was a large seasonal difference in protein and yield with regard to time of cutting, however.

Milk production from nitrate and phosphate treated pasture was doubled, and from cyanamid, trebled over unfertilized plots.

Soil reaction has not changed adversely through proper fertilization.

PROGRESS REPORT ON COMPARISON OF LACTATION AND YEARLY RECORDS

G. M. HARRIS, JAY L. LUSH AND E. N. SHULTZ

Iowa State College, Ames, Iowa

There has been some discussion in recent years of the relative merits of lactation records and Cow Testing Association yearly records as a basis for selecting dairy cows. Production records from 35 herds, including more than 1800 lactation records made by 552 cows and approximately the same number of Cow Testing Association yearly records made by the same cows have been studied, in an attempt to determine which of the two kinds of records is the more accurate.

These 35 herds were selected at random from herds owned by dairymen who had been members of Iowa Cow Testing Associations for at least three years. All records of all cows were used without selection, provided the cow had been in the herd long enough to have made at least two lactation records, and at least two Cow Testing Association yearly records and provided these records appeared to be complete.

The Cow Testing Association yearly records were taken directly from the herd record books. They were computed according to the usual rules of the Association, that is, they were the production records for the Cow Testing Association year. All records were taken excepting those of heifers which freshened during the year and of cows which died or were sold after the year began. The lactation records, on the other hand, were computed to include the production from calving until the cow went dry or, in cases where the cow was in milk more than 12 months, for the first 365 days after the lactation record was started. Both kinds of records were calculated to maturity by the usual 70, 80, and 90 per cent method.

The purpose of this study was to answer the following questions:

1. Is the lactation record more accurate than the Cow Testing Association yearly record; that is, does it tend to repeat itself more closely year after year, thus making it a better criterion upon which to base the culling or selection of dairy cows?

2. If the lactation record is more accurate, is this difference in accuracy sufficient to pay for the additional labor required in its computation?

It is obvious that a record, to be useful in economic culling and for breeding selections, must be such that the future production of the cow shall be rather accurately correlated with it. In other words, in order to be effective for selection purposes, past production records of a cow must

Received for publication July 23, 1934.

Journal Paper No. J184 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 317.

furnish a fairly accurate measure of what she can be expected to produce in the future. The true value of culling or selecting by the use of records is dependent, therefore, upon how closely these records tend to repeat themselves lactation after lactation or year after year as the case may be.

Comparison of these lactation records with the corresponding Cow Testing Association yearly records was made by the method called "analysis of variance" which method was introduced by R. A. Fisher in 1923, for segregating from comparable groups of data the variation traceable to different sources. "Variance" is a term used by Fisher to denote the square of the standard deviation.

As the first step in the comparison, the variance of the lactation records and the variance of the Cow Testing Association yearly records of each individual herd were analyzed independently of the other herds. Then all herds were grouped together into one large population and the variance in this whole population was analyzed for both kinds of records. In each case this total variance was analyzed into those portions attributable to different causes. For example, the variance of the entire population of records from the 35 herds was analyzed into three portions. First, there is a portion caused by influences which operated alike on all cows in the same herd but differed from herd to herd, that "between herds." Second, there is a portion which was caused by things which varied from cow to cow in the same herd but which were always the same in the different lactations of any cow, that "between cows." Finally there is a portion caused by variable conditions which made a cow vary in her production from one lactation to another or from one year to another, that "between records of the same cow."

The differences in these variances were expressed in terms of correlations which show the degree of likeness between records made by the same cow, as compared with the variation existing in the whole population of records. These correlations between records of the same cow show how nearly a cow had the same record lactation after lactation or year after year according to the two methods of figuring her yield.

In table 1 are presented the age corrected records from one herd to illustrate the method of analysis. Some cows varied quite markedly in their production records from one lactation or year to the next while other cows tended to have about the same production records lactation after lactation or year after year. For example, Mildred produced 443 pounds of fat in her first lactation and only 301 pounds of fat in her second lactation. Here is a difference of 142 pounds of fat between her two lactation records. Millie, on the other hand, produced 281 pounds of fat in her first lactation and 278 pounds in her second lactation. Here there is only three pounds difference between Millie's first and second lactation records.

TABLE 1

Age corrected records from one herd illustrating method of analysis

	LACTATION RECORDS AGE IN YEARS							C. T. A. YEARLY RECORDS AGE IN YEARS							
	2	3	4	5	6	7	8	2	3	4	5	6	7	8	9
Kitty					314	322	271						363	319	295
Peach				267	329	256						328	298	310	
Dora			338	241	228						309	231	260		
Alma					418	484	390					412	283	376	
Pansy			314	289	308						328	307	302		
Nervy			333	400							370	297			
Mabel			426	343	290					399	325	336			
Rocky				448	424						389	367			
Andy		356	306						396	353					
Frank	343	331	350					344	329	297					
Mildred	443	301						387	335						
Ring	386	278						386	291						
Kat	230	263						237	291						
Millie	281	278						281	299						

ANALYSIS OF VARIANCE

Source	d/f	Sum of sqs.	Mean sq.
Total	34	148,613	4,371
Between cows	13	101,957	7,843
Between records of the same cow	21	46,656	2,222

Deduced correlation between records of the same cow $= \frac{4,371 - 2,222}{4,371} = .492.$

ANALYSIS OF VARIANCE

Source	d/f	Sum of sqs.	Mean sq.
Total	34	71,753	2,110
Between cows	13	41,677	3,206
Between records of the same cow	21	30,076	1,432

Deduced correlation between records of the same cow $= \frac{2,110 - 1,432}{2,110} = .321.$

If all cows had varied as much as Mildred did, the correlation between records of the same cow in this herd would have been very low, while if all the cows had been as consistent in their production as Millie then the variance between records of the same cow would have been very small and the correlation between the lactation records of the same cow would have been much larger than the correlation of .492 actually found in this herd.

It will be noted at the bottom of table 1, that the mean square or variance has been analyzed into three portions: total, that between cows, and that between records of the same cow. By subtracting the variance between records of the same cow from the total variance, that portion of the total variance which is common to all records of the same cow is obtained. This divided by the total variance gives approximately the average intra-herd correlation between records of the same cow.

The average intra-herd correlations between lactation records and between Cow Testing Association yearly records of the same cow in each of the 35 herds are presented in table 2. In the last column of table 2, the

TABLE 2

Comparison of Lactation Correlations and C. T. A. Correlations for each herd

HERD NO.	NO. OF COWS	NUMBER OF LACTATION RECORDS	NO. OF C. T. A. RECORDS	INDIVIDUAL HERD CORRELATIONS		LACTATION CORRELATION EXCELS C. T. A.
				Lact.	C. T. A.	
1	26	93	93	.353	.234	+
2	27	87	72	.436	.261	+
3	15	57	37	.551	.417	+
4	18	69	59	.154	.080	+
5	7	26	26	.357	.144	+
6	10	32	30	.018	.544	−
7	24	97	89	.608	.644	−
8	6	19	17	.699	.404	+
9	9	36	40	.310	.357	−
10	24	90	93	.143	.342	−
11	12	51	45	.287	.378	−
12	17	55	55	.528	.365	+
13	19	71	60	.470	.411	+
14	16	48	50	.522	.433	+
15	29	102	109	.352	.268	+
16	17	57	53	.246	.088	+
17	11	32	38	.044	.165	−
18	14	38	41	.182	.511	−
19	14	35	35	.492	.321	+
20	12	35	40	.669	.625	+
21	14	46	50	.438	.244	+
22	23	71	72	.418	.516	−
23	14	47	54	.034	.024	+
24	15	41	37	.412	.242	+
25	19	66	58	.256	.120	+
26	9	33	28	.049	.214	−
27	16	59	57	.417	.190	+
28	11	34	33	.321	.129	+
29	16	58	50	.653	.348	+
30	12	36	41	.466	.054	+
31	10	27	32	.227	.088	+
32	10	34	37	.345	.363	−
33	15	44	49	.166	.223	−
34	24	80	79	.420	.287	+
35	17	71	75	.294	.357	−
	552	1877	1834			

herds in which the correlation between lactation records exceeds that between Cow Testing Association yearly records are indicated by a plus sign, while those herds in which the correlation between Cow Testing Association yearly records is greater than that between lactation records are indicated by a minus sign. It will be noted that in 23 of the 35 herds the correlation between the lactation records is the greater. The correlations between the lactation records and between the Cow Testing Association yearly records show marked variations. In general however, there is a tendency for both to be high or both to be low in any one herd.

The results obtained by grouping all the herds together into one large population of records are presented in table 3. This table shows that the correlation between random records from the same herd is 0.328 in the case of the lactation records and 0.344 in the case of the Cow Testing Associa-

TABLE 3

Analysis of variance among all lactation records and among all C. T. A. Yearly Records from the 35 herds

Lactation records not exceeding 365 days

Analysis of variance

VARIANCE DUE TO	D/F	SUM OF SQS.	MEAN SQ.	DEDUCED CORR.
All causes	1876	20,022,132	10,673	$\frac{10,673-7,168}{10,673} = .328^{*}$
Between farms	34	6,817,830	200,524	
Remainder	1842	13,204,302	7,168	$\frac{10,673-4,838}{10,673} = .547^{**}$
Between cows on the same farm	517	6,795,599	13,144	$\frac{7,168-4,838}{7,168} = .325^{***}$
Between records of the same cow	1325	6,408,703	4,838	

C. T. A. yearly records

VARIANCE DUE TO	D/F	SUM OF SQS.	MEAN SQ.	DEDUCED CORR.
All causes	1833	17,469,119	9,530	$\frac{9,530-6,251}{9,530} = .344^{*}$
Between farms	34	6,224,387	183,070	
Remainder	1799	11,244,732	6,251	$\frac{9,530-4,385}{9,530} = .540^{**}$
Between cows on the same farm	517	5,623,602	10,877	$\frac{6,251-4,385}{6,251} = .299^{***}$
Between records of the same cow	1282	5,621,130	4,385	

* Correlation between random records from the same herd.

** Correlation between records of the same cow, all cows being considered as in a single population.

*** Average intra-herd correlation between records of the same cow.

tion yearly records. This degree of likeness between records merely because they were made in the same herd indicates a very significant herd effect. Such an effect results from two major causes. First, the cows in a given herd are, for the most part, subjected to as nearly the same conditions of feeding and management as possible, and second, the inherent productive ability of the cows in a given herd is apt to be more nearly the same than one would expect to find in a random sample of cows from many herds. A herd effect as large as the one noted in these data may be the main explanation for the generally observed fact that the daughter-dam correlation when the sire is held constant, is generally much lower than when computed for a whole population which includes the daughters of many sires from many herds. Many other things besides the sire are "held constant" in such a computation. This large herd effect is also a strong argument for considering in all cullings and selections, how far a record is above or below the average of the herd in which it was made, in addition to considering the absolute size of the record. However, the fact that the correlations 0.328 for lactation records and 0.344 for Cow Testing Association yearly records are so nearly alike indicates that the likeness between records because they

were made in the same herd is almost identical either way the records were figured.

The correlation between records of the same cow, cows from many herds being included in one large population of records, (0.547 for lactation records and 0.540 for Cow Testing Association yearly records), includes the resemblance between the records of a given cow which result not only from the cow's intrinsic productivity but also from the fact that all of each cow's records were made in the same herd, and therefore under much the same peculiarities of management and environment. These two correlations (0.540 and 0.547) are so nearly the same that there is practically no choice between the two as to which is the best measure of a cow's future production.

The average intra-herd correlation between records of the same cow, 0.325 for lactation records and 0.299 for Cow Testing Association yearly records, is an expression of the degree of likeness between records of the individual cow due to her inherent ability to produce. In other words, any peculiarity in the management and environment in a given herd would not affect this correlation insofar as it applied to all records made in that herd, This, therefore, is the best measure of how nearly a cow tends to repeat her production in the same herd lactation after lactation or year after year. Again there is very little difference between the correlation computed from lactation records and the one computed from Cow Testing Association yearly records. The difference that does exist between these two correlations indicates that the lactation records repeats itself a little more closely than the Cow Testing Association yearly record. However, this difference is not at all significant statistically, which means that a difference as large as this might often be found between two such samples of data taken from the very same population.

CONCLUSIONS

From the results of this study it may be concluded that the Cow Testing Association yearly record tends to repeat itself in succeeding years about as closely as the lactation record does. Therefore a general change to the lactation basis for selecting dairy cows, proving dairy sires, etc., will not lead to any material increase in accuracy. Such a change would be hard to justify if it entails any appreciable amount of additional expense or trouble.

Above all, one should never lose sight of the fact that the conditions under which the records were made are important and allowances for them should be made wherever possible. The individual owner can do this to some extent, but the man who has only the production records with no description of the conditions under which they were made can not even begin to make such allowances.

MEMBERS OF AMERICAN DAIRY SCIENCE ASSOCIATION, JULY 15, 1934

A

ABBOTT, FRED H., Dairy Industry Division, College of Agri., Davis, Calif.
ACKERMAN, RICHARD A., Reymann Memorial Farms, Wardensville, W. Va.
ADAMS, HAROLD S., Nashoba Associated Boards of Health, Town Hall, Ayer, Mass.
AHLSTROM, WALTER, 3800 Lyndale Avenue North, Minneapolis, Minn.
AHRENS, ALFRED H., 1179 Forest Ave., Bronx, New York, N. Y.
ALEXANDER, C. B., The Akron Pure Milk Co., 273 Browery St., Akron, Ohio.
ALGER, HARRY B., 13505 Griggs Ave., Detroit, Mich.
ALLEN, NAT. N., University Farm, St. Paul, Minn.
ALMY, E. F., Dept. of Agr. Chemistry, Ohio State Univ., Columbus, Ohio.
ALPIN, RICHARD D., 44 Whittemore Road, Newton, Mass.
ALTWEGG, C. ALBERT, 4 rue Roussel, Paris 17ᵉe, France.
ANDERSON, E. O., Conn. Agri. College, Storrs, Conn.
ANDERSON, GEORGE C., Creamery Package Mfg. Co., 1243 West Washington Blvd., Chicago, Ill.
ANDERSON, J. ARLINGTON, Dept. of Bacteriology, Rutgers University, New Brunswick, N. J.
ANSBACHER, S., The Dry Milk Co. Inc., Bainbridge, N. Y.
AREY, J. A., State College Sta., Raleigh, N. C.
ARMS, WILLARD C., Intervale Jersey Farms, Burlington, Vt.
ARMSTRONG, TALBOTT V., 801 Cherry Ave. N.E., Canton, Ohio.
ARNOLD, P. T. DIX, Dept. of Animal Husb., University of Florida, Gainesville, Fla.
ATKESON, F. W., Dairy Husb. Dept., College of Agri., Moscow, Idaho.
AYRES, HARVEY L., 7 University Road, Hyattsville, Md.
AYRES, W. E., Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y.

B

BAKER, J. E., 854 21st Street, P. O. Box 898, Merced, Calif.
BAKER, M. P., Dairy Ind. Dept., Iowa State College, Ames, Iowa.
BAILEY, DANA H., 719 Fulton St. S.E., Minneapolis, Minn.
BAISLER, WALTER, R. F. D. No. 2, Poland, Ohio.
BALTZER, A. C., Dairy Dept., Michigan State College, East Lansing, Mich.
BARBER, ALBERT H., Cherry-Burrell Corp., 427 West Randolph St., Chicago, Ill.
BARIL, W. A., Wieland Dairy Co., 3014 N. Tripp Ave., Chicago, Ill.
BARIM, MORRIS, Production Mgr., Capitol Dairy, 3114 W. 16th St., Chicago, Ill.
BARNES, JOHN C., Twin City Milk Prod. Assn., 1001 Glenwood Ave., Minneapolis, Minn.
BARTLETT, J. W., Dairy Dept., N. J. Agri. College, New Brunswick, N. J.
BASS, LAWRENCE W., Asst. Director of Research, The Borden Co., 350 Madison Ave., New York, N. Y.
BAYER, A. H., General Ice Cream Corp., 710 Eastern Ave., Schenectady, N. Y.
BEAM, A. LELAND, State College, Pa.
BECHDEL, S. I., State College, Pa.
BECKER, R. B., Animal Ind. Dept., Univ. of Florida, Gainesville, Fla.
BEEBE, D. A., Mgr., United Farmers Coop. Cry. Assn. Inc., 98 Cambridge St., Charlestown, Mass.
BEERS, FRANK S., 211 Reed St., Clearfield, Pa.

BELL, R. W., 4409 Greenwich Parkway, Washington, D. C.
BENDER, C. B., New Jersey Agri. Expt. Sta., Dept. of Dairy Husb., New Brunswick, N. J.
BENDER, DR. RAYMOND, Box 212, Bainbridge, N. Y.
BENDIXEN, H. A., Dept. of Dairy Husb., State College of Wash., Pullman, Wash.
BENNETT, C. L., Frechtling Dairy Co., Front & Wilson Sts., Hamilton, Ohio.
BENNETT, FRED N., Sunshine Farms, Inc., 4th & Union Sts., Lafayette, Ind.
BENNETT, FREDERICK W., Dairy Dept., State College of Agri., Athens, Ga.
BERRY, M. H., Dairy & Animal Husb. Dept., University of Maryland, College Park, Md.
BESEMER, A. M., Golden State Co. Ltd., 425 Battery St., San Francisco, Calif.
BIGELOW, A. P., 255 Homestead Ave., Hartford, Conn.
BIGGS, LEE, Golden State Co. Ltd., Sacramento, Calif.
BIRD, EMERSON W., Dept. of Dairy Industry, Iowa State College, Ames, Iowa.
BIRD, JOHN WILLIAM, Box 25, Truro, Nova Scotia, Canada.
BLACKMAN, CHAS. L., Ohio State University, Columbus, Ohio.
BLACKBURN, PAUL, Beatrice Cry. Co., 1526 State St., Chicago, Ill.
BLAKE, E. SMYTH, Proprietor Blake Dairy, Belton, S. C.
BLIHOVDE, N., Kraft-Phenix Cheese Corp., 400 Rush St., Chicago, Ill.
BODER, FRANCIS J., 432 River Road, Avalon, Pittsburgh, Pa.
BOHSTEDT, GUS, College of Agri., Agricultural Hall, Madison, Wis.
BOONE, IRWIN DEAN, 4317 Maycrest Ave., Los Angeles, Calif.
BORLAND, A. A., Dairy Husb. Dept., State College, Pa.
BOUDEWYNS, CELESTIN, Health Officer, Westwood, N. J.
BOUSKA, FRANK J., Beatrice Cry. Co., Galesburg, Ill.
BOUSKA, F. W., Beatrice Cry. Co., 1526 South State St., Chicago, Ill.
BOWLING, G. A., Dairy Dept., West Virginia Univ., Morgantown, W. Va.
BOYER, WILLARD C., Meyer Dairy Products Co., 3051 E. 63rd St., Cleveland, Ohio.
BRANNON, J. M., Dairy Dept., Univ. of Illinois, Urbana, Ill.
BREED, ROBERT S., New York Agr. Expt. Sta., Geneva, N. Y.
BREMER, HARRY E., State House, Montpelier, Vt.
BRENCE, JOHN L., 426 Clark St., Helena, Mont.
BREWRY, L. A., 1709 Hanover Ave., Richmond, Va.
BRITT, JAMES A., City Consumers Co., Paducah, Ky.
BROCKSCHMIDT, J. H., Y. M. C. A., 13220 Woodward Ave., Highland Park, Mich.
BRODY, SAMUEL, Dairy Building, Univ. of Missouri, Columbia, Mo.
BROWN, CHAS. A., American Dairy Foundation, 228 N. LaSalle St., Chicago, Ill.
BROWN, EDWARD F., Executive Vice President, Milk Research Council, 22 E. 40th St., New York, N. Y.
BROWN, ELIOT E., 227 University Ave., Davis, Calif.
BROWN, HAMLIN L., Extension Dairyman, Gainesville, Fla.
BROWN, L. W., 3402 N. Eleventh St., Milwaukee, Wis.
BROWN, ROYER H., Editor The Jersey Bulletin, 602 Majestic Bldg., 47 S. Pa. St., Indianapolis, Ind.
BROWN, W. CARSON, Dept. of Dairy Husb., College of Agri., W. Va. Univ., Morgantown, W. Va.
BROWNELL, S. J., Dept. of Animal Husb., Cornell Univ., Ithaca, N. Y.
BRUECKNER, HERMAN J., Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y.
BURGWALD, L. H., Dept. of Dairy Technology, Ohio State University, Columbus, Ohio.
BURKE, A. D., Box 205, Alabama Polytechnic Inst., Auburn, Ala.
BURLINGAME, M. M., Borden's Farm Products Co. of Mich., 3600 Forest Ave. E., Detroit, Mich.
BUTTON, F. C., N. J. Agrl. Expt. Station, New Brunswick, N. J.

C

CAHN, MAURICE M., 30 E. 18th St., New York, N. Y.
CAINE, GEO. B., Utah Agri. College, Logan, Utah.
CAMBURN, O. M., Vermont Agr. Expt. Station, 489 Main St., Burlington, Vt.
CAMPBELL, M. H., Dept. of Animal & Dairy Husb., Univ. of Vermont, Burlington, Vt.
CANADIAN DAIRY & ICE CREAM JOURNAL, 122 Richmond St. West, Toronto 2, Canada.
CANNON, C. Y., Animal Husb. Dept., Iowa State College, Ames, Iowa.
CANAN, R. D., 823 Lafayette Life Bldg., Lafayette, Ind.
CARPENTER, DWIGHT C., New York State Agri. Expt. Sta., Geneva, N. Y.
CARSON, ROBERT B., 606 11th Ave., Huntington, W. Va.
CARVER, R. J., Moore-Ross Milk Co., Columbus, Ohio.
CAUFIELD, W. J., Dept. of Dairy Husb., Manhattan, Kansas.
CAVE, H. W., Dairy Dept., College of Agri., Manhattan, Kansas.
CHAPMAN, LEROY M., 293 White St., Danbury, Conn.
CHERBONNIER, E. G., Purina Mills, 8th and Gratoit Sts., St. Louis, Mo.
CHRISTENSEN, SOREM, 1131 10th St., Modesto, Calif.
CLEMENTS, F. E., 1243 W. Washington Blvd., Chicago, Ill.
CLEVENGER, W. L., Dairy Dept., State College, Raleigh, N. C.
COHEE, C. I., 219 N. Broad St., Philadelphia, Pa.
COLE, ARTHUR W., 825 Grant St., Klamath Falls, Ore.
COLE, WILFORD C., College of Agri., Davis, Calif.
COLLINS, DR. MERVYA, Mount Royal Dairies, 1200 Papineau Ave., Montreal, Quebec, Canada.
COLMAN, H. N., Dairy Dept., Oregon State College, Corvallis, Ore.
COMBS, W. B., Dairy Division, University Farm, St. Paul, Minn.
CONKLIN, C. T., Sec., Ayrshire Breeders Ass'n., Brandon, Vt.
CONNELL, FRANK M., 205 N. Highland Ave., York, Pa.
CONNELLY, R. G., Dept. of Dairying, College of Agri., Blacksburg, Va.
COOK, ALBERT, 2012 8th Ave. N., Great Falls, Mont.
COOK, A. S., Walker-Gordon Lab. Co., Plainsboro, N. J.
COOLEY, LOUIS A., Mgr. Country Dept., Whiting Milk Co., 570 Rutherford Ave., Boston, Mass.
CORBETT, L. S., Orono, Maine.
CORBIN, C. I., 524 W. 57th St., New York, N. Y.
CORDES, WILLIAM A., Blue Valley Creamery Co., 1137 S. Jackson Blvd., Chicago, Ill.
COTTON, W. P., 229 Daylight Bldg., Knoxville, Tenn.
COULTER, S. T., University Farm, St. Paul, Minn.
COX, C. G., 4410½ Drexel Blvd., Chicago, Ill.
CRAMER, A. J., 522 N. Pinckney St., Madison, Wiss.
CRANDALL, A. T., Jonesville, Vt.
CRANDALL, W. T., New York State College of Agri., Cornell Univ., Ithaca, N. Y.
CROSBY, J. E., JR., Dairy Dept., Univ. of Missouri, Columbia, Mo.
CROSSNO, ROBT. GUINNE, Tennecsee Valley Authority, Norris, Tenn.
CROWE, L. K., Dairy Dept., Univ. of Nebraska, Lincoln, Nebraska.
CUMMINGS, C. M., Advanced Register Div., The American Guernsey Cattle Club, Peterboro, N. H.
CUNNINGHAM, O. C., Dairy Dept., College of Agri., State College, N. Mexico.
CUNNINGHAM, W. S., Univ. of Arizona, Tucson, Ariz.

D

DAHLBERG, A. C., Experiment Station, Geneva, N. Y.
DALTON, THOS. I., Kansas State Board of Health, Topeka, Kansas.

DARNELL, A. L., College Station, Texas.
DAVIS, GLENN G., Fredmar Farms, Jefferson Barracks, Mo.
DAVIS, H. P., Dairy Dept., College of Agri., Lincoln, Neb.
DAVIS, R. N., College of Agri., Tucson, Ariz.
DELISLE, RODNEY, 2195 West 40th Ave., Vancouver, B. C., Canada.
DEMOSS, WILLIAM RAY, Univ. of Tenn. Junior College, Martin, Tenn.
DICE, J. R., Dairy Husb. Dept., North Dakota Agri. College, Fargo, N. Dak.
DICKSON, JAMES C., 516 Vine St., Marion, Ohio.
DOAN, F. J., Dairy Dept., Penn. State College, State College, Pa.
DORCAS, M. J., 362 Front St., Berea, Ohio.
DORMAN, D. M., 325 Roosevelt Bldg., Los Angeles, Calif.
DORSEY, L. M., Dairy Division, University of Maine, Orono, Maine.
DORSEY, WARNER A., Latrobe Dairy Co., Box 133, Youngwood, Pa.
DOWNS, P. A., Dept. of Dairy Husb., University of Nebraska, Lincoln, Neb.
DREYER, VIRGIL O., 219 E. Fifth St., Dayton, Ohio.
DWYER, GEORGE L., Box 386, Waterbury, Vt.

E

EASTERN STATES FARMERS' EXCHANGE, Springfield, Mass.
EASTWOOD, H. S., DeLaval Separator Co., 165 Broadway, New York, N. Y.
EDWARDS, FRANCIS REES, Dept. of Animal Industry, Georgia Expt. Sta., Experiment, Ga.
ELLENBERGER, H. B., Univ. of Vermont, Burlington, Vt.
ELY, FORDYCE, University of Kentucky, Lexington, Ky.
ENGLAND, C. W., Dairy Bldg., Univ. of Maryland, College Park, Md.
ERB, J. HOFFMAN, College of Agri., Ohio State Univ., Columbus, Ohio.
ERF, OSCAR, Ohio State Univ., Townsend Hall, Columbus, Ohio.
ESPE, DWIGHT L., 612 Lynn Ave., Ames, Iowa.
ETTER, R. M., 2454 Cleveland Ave., Columbus, Ohio.
EVES, RALPH L., 10002 Catherine St., Meadville, Pa.

F

FABIAN, F. W., Div. of Vet. Science, Mich. Agrl. College, East Lansing, Mich.
FAIRES, EARL W., Sandhill Expt. Sta., Route 5, Columbia, S. C.
FARRALL, A. W., Creamery Package Mfg. Co., 1243 W. Washington St., Chicago, Ill.
FAWCETT, CLIFFORD J., Mass. State College, Amherst, Mass.
FAY, A. C., Kansas State Agr. College, Manhattan, Kansas. Bact. Dept.
FIELDER, H. S., Cherry-Burrell Corp., 427 W. Randolph St., Chicago, Ill.
FISHER, R. C., R. F. Worden & Sons, Inc., Waterbury, Conn.
FITCH, J. B., Dept. of Dairy Husb., Kansas State College, Manhattan, Kansas.
FITTS, F. B., 213 Dairy Bldg., Penn. State College, State College, Pa.
FLANIGAN, GEORGE E., Box 168, Bainbridge, N. Y.
FLATT, J. I., Gen. Mgr., Hamilton Pure Milk Dairies, John St., Hamilton, Ontario, Canada.
FLEMING, R. S., The Borden Co., Syracuse, N. Y.
FLETCHER, JOEL L., Dept. of Agri., Southern La. Inst., 201 Brashear St., Lafayette, La.
FOLEY, DAN, 617 Marin St., Vallejo, Calif.
FOLEY, RICHARD C., Farm House, Mass. State College, Amherst, Mass.
FOLKERS, ELWYN C., Plant Production Mgr., Division of Beatrice Meadow Gold Dairies, White Mountain Cry. Co., Lima, Ohio.
FOSKETT, CLIFFORD R., 382 Dixwell Ave., New Haven, Conn.
FOURT, D. L., Univ. Ext. Division, Boise, Idaho.

FRANDSEN, J. H., Mass. State College, Amherst, Mass.
FRASER, W. J., Univ. of Illinois, Urbana, Ill.
FRASER VALLEY MILK PRODUCERS ASSOCIATION, 405 8th Ave. West, Vancouver, B. C., Canada.
FRAZIER, WILLIAM C., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
FRAYER, JAMES M., Agr. Expt. Sta., 489 Main St., Burlington, Vt.
FRY, E. BERNICE, College of Agri., Davis, Calif.
FREDERIKSEN, FELIX M., 725 McIndoe St., Wausau, Wis.
FRETWELL, C. B., Drawer 972, Spartanburg, S. C.
FREVERT, G. E., Del Norte Milk Products Co., Smith River, Calif.

G

GAINES, W. L., Dept. of Dairy Husb., Univ. of Illinois, Urbana, Ill.
GALEMA, M. L., 2504 183rd St., Oak Glen, Ill.
GAMBLE, JAMES A., Beltsville, Md.
GANNON, E. A., Purdue Univ., Lafayette, Ind.
GARDINER, LAURENCE B., 1863 Camden Ave., Memphis, Tenn.
GARDNER, W. U., Dept. of Anatomy, Yale Univ., New Haven, Conn.
GARRISON, E. R., Dairy Dept., College of Agri., Columbia, Mo.
GAVIN, JOSEPH S., 200 Stockbridge Ave., Buffalo, N. Y.
GEARHART, C. R., Pa. State College, State College, Pa.
GEBHARDT, H. T., 418 Milford Ave., Marysville, Ohio.
GEORGIDSE, AMBERSEY, Lab. & Mfg. Dept., Grandview Dairy Inc., Webster's Crossing, Livingston, N. Y.
GERMANN, A. F. O., 4614 Prospect Ave., Cleveland, Ohio.
GIFFORD, WARREN, The Dept. of Dairy Husb., College of Agr., Morgantown, W. Va.
GIRARD, JAY D., 25 Good Shephard Terrace, Garrett Hill, Pa.
GOLDING, N. S., University of Idaho, Moscow, Idaho.
GOOD, CHARLES K., 2138 Blakemore Ave., Nashville, Tenn.
GOSS, W. G., 727 Seward St., Evanston, Ill.
GRAVES, R. R., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
GRAY, C. E., 6263 Chabot Road, Oakland, Calif.
GREGORY, H. W., Dept. of Dairy Husb., Purdue Univ., Agri. Expt. Sta., Lafayette, Ind.
GREEN, H. H. VANCE, The Grove City Cry., Lincoln Ave., Grove City, Pa.
GREENE, SAM H., Account Dept., Calif. Dairy Council, 216 Pine St., San Francisco, Calif.
GRINNELLS, C. D., State College Sta., Raleigh, N. C.
GROW, WALTER, Mgr. Fluid Milk Plant, 265 Beech St., Pottstown, Pa.
GRUBER, N. S., 910 Stephenson Bldg., Detroit, Mich.
GUELLOW, CREIGHTON N., University Farm Cry., Davis, Calif.
GULLICKSON, T. W., Univ. of Minn., St. Paul, Minn.
GUTHRIE, E. S., Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y.
GUYNETTE, A. M., West End Dairy, N.W. Cor. Bee and President Sts., Charleston, S. C.

H

HADLEY, I. D., 801 N. Grant St., Wooster, Ohio.
HAINES, GEORGE, Office of Expt. Stations, Washington, D. C.
HALE, JOSEPH C., 3333 Lee Road, Shaker Heights, Cleveland, Ohio.
HALESKI, FRANK, 30 West 85th St., New York, N. Y.
HAMILTON, ROBERT, 1401 Eighth Ave., Huntington, W. Va.
HAMMER, B. W., Iowa State College, Ames, Iowa.
HANAWALT, E. M., P. O. Box 540, Massillon, Ohio.

HANSEN, A. P., Statens Forsogsmejeri, Hillerod, Denmark.
HANSON, F. E., College of Agri. Univ. of Wisconsin, Madison, Wis.
HARDELL, ROBT., 1517 15th Ave., Monroe, Wis.
HARDING, H. G., 273 Bowery St., Akron, Ohio.
HARDING, J. M., Harding Cream Co., Omaha, Neb.
HARFORD, ZAIDA M., The Dry Milk Research Lab., Box 535, Bainbridge, N. Y.
HARMISON, HERBERT, 698 White St., Dubuque, Iowa.
HARMON, E. M., 11 Poplar Ave., Takoma Park, Md.
HARRIS, J. L., Box 173, Kouts, Ind.
HARRIS, ROY T., Dairy Records Office, Madison, Wis.
HARRISON, HARTMAN K., Linden Ave. & Dolphin St., Baltimore, Md.
HASTINGS, E. G., Univ. of Wisconsin, Madison, Wis.
HAYDEN, C. C., Experiment Station, Wooster, Ohio.
HAZELWOOD, BEN P., P. O. Box 367, Jackson, Tenn.
HEADLEY, F. B., Agr. Expt. Sta., Univ. of Nevada, Reno, Nevada.
HEFFERMAN, H. N., Reg. Sec., The Certified Milk Producers Association of America, 6269 Colbert St., New Orleans, La.
HEINEMANN, HENRY E. O., Milk Plant Monthly, 327 S. LaSalle St., Chicago, Ill.
HEMB, D. M., Elgin Milk Products Co., 658 West Grand Ave., Chicago, Ill.
HENDERSON, H. O., College of Agri., Morgantown, W. Va.
HENDERSON, J. LLOYD, College Park, Davis, Calif.
HENING, J. C., New York Agri. Expt. Sta., Geneva, N. Y.
HENRY, WILL W., Mgr., Dairy Coop. Assn., 1313 East 11th St., Portland, Ore.
HERMAN, HARRY A., Dept. of Dairy Husb., College of Agri., Columbia, Mo.
HERREID, ERNEST, Division of Dairy Husb., Univ. Farm, St. Paul, Minn.
HERRINGTON, B. L., Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y.
HERRMAN, LOUIS F., 400 Stewart St., Morgantown, W. Va.
HIBBERT, C. W., Challenge Cream & Butter Assn., 925–929 East Second St., Los Angeles, Calif.
HIDINGER, ORVIS, 205 Times Bldg., Scranton, Pa.
HIGGINS, L. A., Starkville, Miss.
HILEMAN, J. L., Dairymen's League, 810 Burnett, Syracuse, N. Y.
HILL, OTTO J., Extension Service, Pullman, Wash.
HILTON, J. H., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
HINMAN, ELMER S., N. Walnut St., Spring Grove, Pa.
HODGSON, R. E., Western Washington Expt. Sta., Puyallup, Washington.
HODSON, HAROLD G., 2922 Jermain Drive, Toledo, Ohio.
HOFFMAN, JOHN, c/o Dairy Coop., 1313 S.E., 12th St., Portland, Ore.
HOLCOMBE, CHAS. H., 735 Pine St., Sauk Centre, Minn.
HOLDAWAY, C. W., Dept. of Dairy Husb., Virginia Polytechnic Inst., Blacksburg, Va.
HOLZHAUER, HENRY K., Moss Dairy Farm, Inc., Chesterland, Ohio.
HOMBERGER, ROBT, E., 1418 Hayes Ave., Sandusky, Ohio.
HOOD, E. G., Dairy Commissioner's Office, Ottawa, Canada.
HOOPER, H. A., Dept. of Animal Husb., Cornell Univ., Ithaca, N. Y.
HOPKINS, J. N., 2032 W. Grace St., Richmond, Va.
HORROLL, B. E., Purdue Univ., Dairy Husb. Dept., Lafayette, Ind.
HORWOOD, RUSSELL E., Experiment Station, Chatham, Mich.
HOWAT, R. J., The Dry Milk Industry, 221 North LaSalle St., Chicago, Ill.
HOWE, D. K., c/o Fairmont Cry. Co., Omaha, Nebr.
HUCKER, G. J., New York State Agri. Expt. Sta., Geneva, N. Y.
HUFFMAN, CARL F., Dairy Dept., Mich. Agrl. College, East Lansing, Mich.

HUNZIKER, O. F., Blue Valley Creamery, Chicago, Ill.
HUSSONG, R. V., Dairy Industry Dept., Iowa State College, Ames, Iowa.
HUTTON, C. A., Extension Dairyman, Knoxville, Tenn.

I

INGHAM, LEROY W., Dairy Dept., Univ. of Maryland, College Park, Md.
IVERSON, C. A., Dept. of Dairying, Iowa State College, Ames, Iowa.

J

JACKSON, H. C., Dairy Dept., Univ. of Wisconsin, Madison, Wis.
JACOBSEN, D. H., Dept. of Dairy Husb., South Dakota State College, Brookings, S. D.
JANZEN, HAROLD W., Marigold Dairies, Red Wing, Minn.
JENSEN, CHRIS, Dairy Dept., State College Station, Fargo, N. Dak.
JENSEN, W. F., American Assoc. Creamery Butter Manufacturers, 1404 Chicago Mercantile Exchange, Chicago, Ill.
JERTSON, E. C., Krem-Ko Co., 4830 S. Turner Ave., Chicago, Ill.
JEWELL, R. M., 618 East High St., Mt. Vernon, Ohio.
JOHNSTON, FLOYD, College of Agri., Ames, Iowa.
JONES, IDWAL R., Dairy Dept., Oregon Agr. College, Corvallis, Ore.
JONES, FRANK L. SEYMOUR, c/o The Borden Co., 350 Madison Avenue, New York N. Y.
JONES, M. E., 341 N. Third St., Tippecanoe City, Ohio.
JONES, W. F., Ottawa Dairy Ltd., Ottawa, Canada.
JUDKINS, H. F., National Dairy Products Corp., 120 Broadway, New York, N. Y.

K

KEAY, JOHN, 420 Steadacona St., W., Moose Jaw, Saskatchewan, Canada.
KEITH, J. I., Dairy Husb. Dept., Oklahoma A. & M. College, Stillwater, Okla.
KELLY, C. D., Old Tavern Farm, Inc., 20 Danforth St., Portland, Maine.
KELLY, ERNEST, Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
KELLY, FRANK W., c/o Gridley Dairy Co., 620 N. 8th St., Milwaukee, Wis.
KENDRICK, J. F., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
KING, CHARLES GLEN, Chemistry Dept., Univ. of Pittsburgh, Pittsburgh, Pa.
KNAYSI, GEORGES, Dairy Industry Bldg., Cornell Univ., Ithaca, N. Y.
KNOTT, J. C., Dept. of Dairying, State College of Wash., Pullman, Washington.
KOCHER, DANIEL S., Ames Farm Dairy Co., 31st and Gillham Road, Kansas City, Mo.
KOHLER, ROLAND, 2101 S. Los Angeles St., Los Angeles, Calif.
KOSTAKOS, S. A., 351 W. Huron St., Chicago, Ill.
KRAUSS, WILLIAM E., Ohio Agri. Expt. Sta., Wooster, Ohio.
KREHBIEL, LEONARD F., 3720 Hughes Ave., Palms, Calif.
KRILL, IVIN R., c/o Moores & Ross Inc., 165 N. Washington Ave., Columbus, Ohio.
KUHLMAN, A. H., Dairy Dept., Oklahoma A. & M. College, Stillwater, Okla.

L

LACOSTA, CARLOS, Dorado, Porto Rico.
LAMASTER, J. P., Division of Dairying, Clemson College, S. C.
LARSEN, C., State College, Brookings, S. D.*
LARSEN, HUGO J., 3301 Highland Ave., Drexel Hill, Pa.
LARSON, C. W., 235 Elm St., Buffalo, N. Y.
LATZER, R. L., 1401 Arcade Bldg., St. Louis, Mo.
LAWLER, T. W., 10515 Fidelity Ave., Cleveland, Ohio.

* Dean Larsen's name was omitted in the 1932 membership list through error.

LEHMUKL, HENRY, 73 Howell St., Rochester, N. Y.
LEIGHTON, P. O., Box 5, Brentwood, Md.
LEIGHTON, RAMER, Univ. Farm, St. Paul, Minn.
LEIGHTY, THOMAS C., Connellsville Pure Milk Co., 1101 W. Crawford Ave., Connellsville, Pa.
LEITCH, RENWICK, West of Scotland Agri. College, Dairy Research Laboratories, Auchincruive, Ayrshire, Scotland.
LESCURE, J. M., Division of Farm Insp., Room 900, Sanitary Section, Municipal Office, Baltimore, Md.
LIDE, B. M., JR., 2008 Pine St., St. Louis, Mo.
LINDQUIST, HARRY G., Mass. State College, Dept. of Dairy Industry, Amherst, Mass.
LINN, J. W., Extension Division, College of Agri., Manhattan, Kansas.
LIST, W. H., Assn. of Ice Cream Mfgrs. of New York State, Hotel Pennsylvania, Seventh Ave. & 34th St., New York.
LITTLE, R. E., Sec. International Milk Dealers Assn., 228 N. LaSalle St., Chicago, Ill.
LIVERS, HERBERT B., 323 Second Ave., Escondido, Calif.
LOCHRY, H. R., P. O. Box 251, Sugar Creek, Ohio.
LOVELAND, E. H., 101 Henry St., Burlington, Vt.
LUCAS, P. S., Dairy Dept., E. Lansing, Mich.
LUSH, JAY L., Agricultural Hall, Iowa State College, Ames, Iowa.
LUSH, R. H., Dept. of Animal Husb., Agri. Expt. Sta., La. State Univ., Baton Rouge, La.
LYONS, THEODORE A., 78 Beechmont Ave., Bridgeport, Conn.

M

MACK, M. J., Mass. State College, Amherst, Mass.
MACY, HAROLD, Division of Dairy Husb., University Farm, St. Paul, Minn.
MALLOY, LOUIS J., Mgr., Malloy's Dairy, 326 West Centre St., Shenandoah, Pa.
MANLY, L. A., 354 11th Ave., San Diego, Calif.
MANN, ALBERT I., Dairy Dept., Conn. Agri. College, Storrs, Conn.
MANUS, LOUIS J., Dept. of Dairy Husb., College of Agri., Morgantown, W. Va.
MARTIN, WILLARD H., Dairy Husb. Dept., Kansas Agri. College, Manhattan, Kansas.
MARVIN, L. H., c/o Brooknoll Farm, Essex Junction, Vt.
MAUGHAN, M. O., Milk Council, Inc., 228 N. LaSalle St., Chicago, Ill.
MAYNARD, L. A., Laboratory of Animal Nutrition, Cornell Univ., Ithaca, N. Y.
MCCANN, J. C., New Jersey Agri. Expt. Sta., New Brunswick, N. J.
MCCHESNEY, E. R., Fairmont Cry Co., Buffalo, N. Y.
MCCLELLAND, MILBURN, Asst. Production Mgr., Borden's Ice Cream Co. of Chicago, 7934 Dante Ave., Chicago, Ill.
MCCLELLAND, W. T., Shamrock Dairy, Tucson, Ariz.
MCCOWN, C. Y., Research Dept. Cry. Package Co., 1243 W. Washington Blvd., Chicago, Ill.
MCDONALD, CHARLES S., 66 E. Northwood Ave., Columbus, Ohio.
MCDOWELL, J. C., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
MCGILLIARD, P. C., Dairy Dept., Oklahoma A. & M. College, Stillwater Okla.
MCGRATH, JOHN, Milton, Vt.
MCKELLIP, IVAN, Animal Husb. Dept., Ohio State Univ., Columbus, Ohio.
MCINTYRE, C. W., Hatch Farm, Oakwood, Mo.
MCKINNEY, WM. B., 44 Lester Place, New Rochelle, N. Y.
MEIGS, E. B., 1736 M St., N.W., Washington, D. C.
MEISTER, ALBERT, 323 16th St., Sacramento, Calif.
MERRILL, A. R., Ext. Dairyman, Conn. Agri. College, Storrs, Conn.
MEYER, DAVID A., Apt. 14, 9610 Lamont St., Cleveland, Ohio.

MICHAELIAN, M. B., Dairy Ind. Bldg., Iowa State College, Ames, Iowa.
MILLER, ELIZABETH J., 220 Prospect Road, Haddonfield, N. J.
MILLER, NORMAN J., Mead Johnson & Co., Evansville, Ind.
MILLS, STERLING E., Mitchell Dairy Co., Derby Ave., Orange, Conn.
MILONE, NICHOLAS A., Bureau of Milk Sanitation, State Dept. of Health, Albany, N. Y.
MINSTER, CLYDE H., 1603½ Covert St., Parkersburg, W. Va.
MISCALL, GORDON, Dairy Industry Bldg., Cornell Univ., Ithaca, N. Y.
MIYAWAKI, A., Hokkaido Imperial Univ., Sapporo, Japan.
MOLDAVAN, ANDREW, 1025 Aqueduct St., Guaranteed Pure Milk Co., Montreal, Quebec, Canada.
MONRAD, K. J., Chr. Hansen's Lab. Inc., Little Falls, N. Y.
MONROE, C. F., Ohio Agri. Expt. Sta., Wooster, Ohio.
MOODY, MARK H., 16 N. Main St., Waterbury, Conn.
MOORE, EWDARD H., 35 E. Plaza Place, Pleasantville, N. J.
MOORE, HERBERT C., University of New Hampshire, Durham, N. H.
MOORE, J. S., A. & M. College, Miss.
MORGAN, R. F., Dept. of Dairy Husb., University of Nebraska, Lincoln, Neb.
MORLEY, LEWIS W., American Jersey Cattle Club, 324 W. Twenty-third St., New York, N. Y.
MORRIS, A. J., Dept. of Dairy Husb., Utah State Agri. College, Logan, Utah.
MORRISON, F. B., Dept. of Animal Husb., Cornell Univ., Ithaca, N. Y.
MORRISON, HENRY, Dairy Dept., University of Kentucky, Lexington, Ky.
MORROW, KENNETH, Dairy Bldg., Dairy Husb. Dept., Univ. of New Hampshire, Durham, N. H.
MORSE, ROGER W., College of Agri., Corvallis, Oregon.
MOSELEY, THOMAS W., Beltsville Expt. Farm, Beltsville, Md.
MOSELEY, W. K., 4912 E. Washington St., Indianapolis, Ind.
MOSS, J. R., Dairy Dept., Clemson College, S. C.
MUDGE, COURTLAND S., University Farm, Davis, Calif.
MUELLER, W. S., Dept. of Dairy Industry, Mass. State College, Amherst, Mass.
MURPHY, O. C., 2300 McCoy St., Kansas City, Mo.
MYERS, E. M., New York School of Agri., Alfred, N. Y.
MYERS, R. P., 1403 Eutaw Place, Baltimore, Md.

N

NAFIS, LOUIS F., 111 North Canal St., Chicago, Ill.
NAGOETTE, JOE, Dairy Extension Specialist, Dairy Building State College, Pa.
NEAL, WAYNE M., Dept. of Animal Husb., Agr. Expt. Sta., Univ. of Florida, Gainesville, Fla.
NELSON, D. H., Dairy Division, University Farm, Davis, Calif.
NELSON, J. A., Dept. Dairy Industry, Montana State College, Bozeman, Mont.
NEUHAUSER, MAURICE D., Rauner Ice Cream Co., 3232 S. Lafayette St., Ft. Wayne, Ind.
NEUMAN, WALTER A., 407 Sixth St. West, Huntington, W. Va.
NEVENS, W. B., College of Agri., Urbana, Ill.
NEWLANDER, J. A., University of Vermont, Burlington, Vt.
NORTON, H. W., JR., Madison, Wis.
NYSTROM, A. B., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.

O

OEHMCKE, RICHARD R., Chilocco Indian Agri. School, Chilocco, Okla.
OLMSTEAD, R. H., Dairy Department, State College, Pa.

OLSON, HAROLD C., Dairy Industry Dept., College of Agri., Ames, Iowa.
OLSON, T. M., Brookings, S. Dak.
OMMODT, CHAS., 2283 Alden Place, St. Paul, Minn.
OSBORNE, R. E., 1450 Allison Ave., Los Angeles, Calif.
OTTING, H. E., R. D. 3, Westerville, Ohio.

P

PALEY, CHARLES, Certified Laboratories, 13–19 Hudson St., New York, N. Y.
PALMER, LEROY S., University Farm, St. Paul, Minn.
PARAFITT, E. H., Dairy Dept., Purdue Univ., West Lafayette, Ind.
PARKER, HORATIO N., Engineer Bldg., Main & Orange Sts., Jacksonville, Fla.
PARKER, JOSEPH B., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
PARKER, MILTON E., 123 N. Washington Ave., Danville, Ill.
PARKIN, IVAN E., 33 Dorothy St., Hartford, Conn.
PARSONS, C. H., Swift & Co., Chicago, Ill.
PERKINS, A. E., Expt. Station, Wooster, Ohio.
PERRY, E. J., New Jersey Agri. College, New Brunswick, N. J.
PETERSEN, W. E., Dairy Dept., University Farm, St. Paul, Minn.
PETTEE, D. A., New England Milk Producers Assn., 51 Cornhill, Boston, Mass.
PHILLIPS, CLEMENT A., Dept. of Dairy Industry, Univ. of Wis., Madison, Wis.
PHILLIPS, C. L., The Mission Ranch, Phoenix, Ariz.
PIERCE, RAYMOND H., 24 Jaenicke Lane, Hamden, Conn.
PLUM, MOGENS, Agri. Hall, Iowa State College, Ames, Iowa.
POTTS, ROY C., Bureau of Agri. Economics, U. S. D. A., Washington, D. C.
POWERS, A. J., Borden's Farm Products Co. Inc., 90 Third Ave., Brooklyn, N. Y.
PRATT, AVERY D., Dairy Dept., Virginia Polytechnic Inst., Blacksburg, Va.
PRATT, HAROLD T., Philadelphia Dairy Products Co., 4th & Poplar Sts., Philadelphia, Pa.
PRETZ, O. L., 1020 McGee St., Kansas City, Mo.
PRICE, WALTER V., Hiram Smith Hall, Univ. of Wisconsin, Madison, Wis.
PRITCHETT, COE, Pure Milk Producers Assn. Inc., 853 Livestock Exch. Bldg., Kansas City, Mo.
PRITCHETT, PAUL S., Mead Johnson & Co., Evansville, Ind.
PROUTY, CHAS. C., Wash. Agri. Expt. Sta., College of Agri., Pullman, Wash.
PUTNAM, GEORGE W., 116 6th St., Wilmette, Ill.

Q

QUENCER, ARTHUR, 542 E. 19th St., New York, N. Y.
QUIGLEY, J. V., 5633 Troost Ave., Kansas City, Mo.
QUINN, J. D., P. O. Box 446, Water Valley, Miss.

R

RABILD, HELMER, Titusville Dairy Products Co., Titusville, Pa.
RAGSDALE, A. C., Univ. of Missouri, Columbia, Mo.
RAMSEY, R. J., 901 S. Oak St., Champaign, Ill.
RAY, L. E., JR., 222 Eeel River Ave., Logansport, Ind.
REED, O. E., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
REDDING, C. H., 1606 Second St., Jackson, Mich.
REGAN, J. J., 11 West 42nd St., New York, N. Y.
REGAN, M. J., Dairy Dept., College of Agri., Columbia, Mo.
REGAN, W. M., Agr. Expt. Sta., Davis, Calif.
REICHERT, E. L., Dept. of Dairy Husb., Univ. of Nebraska, Lincoln, Nebr.

REICHLE, C. J., Borden's Farm Products Co. of Michigan, 3600–3674 Forest Ave. E., Detroit, Mich.
RENNER, E. W., Dairy Husb. Div., College Station, Texas.
RENNER, K. M., Texas Technological College, Lubbock, Texas.
REPHAN, HYMAN, Sanitary Dairy, Charleston, S. C.
REYNOLDS, FRANKLIN P., JR., 723 S. State St., Salt Lake City, Utah.
RICE, FRANK E., c/o Evaporated Milk Assn., 203 N. Wabash Ave., Chicago, Ill.
RICHARDS, WM. I., 2419 4th Ave., N.W., Calgary, Alberta, Canada.
RICHARDSON, GEORGE A., University Farm, Davis, Calif.
RICHIE, H. B., Chemical Lab., Swift & Co., Union Stock Yards, Chicago, Ill.
RISHOI, A. H., Dairy Industry Bldg., Cornell Univ., Ithaca, N. Y.
ROADHOUSE, C. L., Univ. of California, Davis, Calif.
ROBERTS, GEORGE V., Milton, Vt.
ROBERTSON, A. H., Director of State Food Lab., New York State Dept. of Agri. and Markets, State Office Bldg., Albany, N. Y.
RODDY, J. B., Columbia, S. C.
ROGERS, DOUGLAS A., Chief Chemist, General Milk Co., Inc., Schoonhoven, Holland.
ROGERS, L. A., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
ROSEBERRY, LAURENCE G., 219 N. Second St., Pottsville, Pa.
ROSNEAU, FRED, Dairy Division, Helena, Mont.
ROSS, HARRY ALBERT, Bureau of Economics, The Borden Co., 350 Madison Ave., New York, N. Y.
ROSS, H. E., Cornell Univ., Ithaca, N. Y.
ROUNDY, JOLA DOYLE, Univ., Dairy Barns, Madison, Wis.
RUEHE, H. A., Dairy Dept., College of Agri., Urbana, Ill.
RUFFNER, R. H., Dept. of Animal Husb., State College Sta., Raleigh, N. C.
RUPEL, I. W., College of Agri., Agricultural Hall, Madison, Wis.
RUSSELL, WM. R., Mandan Cry. & Produce Co., 203 Seventh Ave., N.W., Mandan, N. Dak.

S

SAFFORD, C. E., State Food Lab., State Office Bldg., Albany, N. Y.
SALISBURY, GLENN W., Dept. of Animal Husb., College of Agri., Ithaca, N. Y.
SALISBURY, S. M., Dept. of Animal Husb., Ohio State Univ., Columbus, Ohio.
SALZBERG, H. K., Research Chemist, Mellon Inst., Thackeray Ave. & O'Hara St., Pittsburgh, Pa.
SARTORI, HAYDEN J., P. O. Box 835, Tulare, Calif.
SAVAGE, E. S., Animal Husb. Dept., New York College of Agri., Ithaca, N. Y.
SCHAEFER, O. G., Meredith Publications, Room 2304, 420 Lexington Ave., New York, N. Y.
SCHEIDENHELM, E. C., Dairy Extension, Dairy Bldg., Univ. of Nebraska, Lincoln, Nebr.
SCHMEITER, ROY, U. S. D. A., Food & Drug Adm., Washington, D. C.
SCHROEDER, HERMAN C., Hanovia Chem. & Mfg. Co., 5717 Dorchester Ave., Chicago, Ill.
SCISM, SAMUEL F., DeLuxe Ice Cream Co., 4218 Laclede Ave., St. Louis, Mo.
SCOTT, RALPH E., Box 29, Short Beach, Conn.
SEARING, LYALL D., 5925 N. Commercial Ave., Portland, Ore.
SEARLES, H. R., Agr. Extension Div., University of Minnesota, University Farm, St. Paul, Minn.
SEATH, DWIGHT M., Extension Div., Kansas State College, Manhattan, Kansas.
SEFRANKA, LOUIS ALBERT, 1611 Foster Ave., Brooklyn, N. Y.
SEIDEL, MARTIN, 403 E. John St., Bay City, Mich.
SHARP, PAUL F., Cornell Univ., Ithaca, N. Y.

SHEA, WILLIAM, Box 332, Great Falls, Mont.
SHELLENGER, KERN K., R. F. D. No. 1, Jackson, Ohio.
SHEPARDSON, C. N., Dept. of Dairy Husb., Texas A. & M. College, College Sta., Texas.
SHERE, LEWIS, 53 W. Jackson Blvd., The Diversey Corp., Chicago, Ill.
SHERMAN, J. M., Dairy Industry Bldg., Ithaca, N. Y.
SHIMA, ED., Sugar Bowl Ice Cream Co., Decorah, Iowa.
SHIMMONS, A. V., Box 106, Point Loma, Calif.
SHOEMAKER, S. M., Eccleston, Md.
SHRADER, DR. J. H., 1403 Eutaw Place, Baltimore, Md.
SHULTZ, EARL N., Extension Service, Iowa State College, Ames, Iowa.
SIDELMANN, I. O., State College, Pa.
SIMMONS, ROSWELL CLAY, 1709 Sonoma Ave., Berkeley, Calif.
SMART, PAUL H., Carnation Evap. Milk Co., Coshocton, Ohio.
SMITH, A. I., Box 24, Knoxville, Tenn.
SMITH, EUGENE W., Farmers Dairy Products Co., 517 Fayette St., Cumberland, Md.
SMITH, F. E. A., Director Production United Farmers' Coop. Cry. Assn., Morrisville, Vt.
SMITH, O. D., Dept. of Vocational Subjects, Normal Station, Norway, Ark.
SMITH, R. W., JR., Dept. of Dairy Manufactures, Univ. of Vermont, Burlington, Vt.
SNYDER, WILLIAM, 824 N. 8th St., Lebanon, Pa.
SOLIS, MENALCO, Apartado Postal 173 Panama, Panama.
SOMMER, H. H., Dept. of Dairy Husb., Univ. of Wisconsin, Madison, Wis.
SOURAPAS, GEORGE, National Ice Cream Co., 2747 W. Harrison St., Chicago, Ill.
SOUTHWELL, B. L., Ga. Coastal Plain Expt. Station, Tifton, Georgia.
SPECHT, W. A., 617 Union St., Millersburg, Pa.
SPENCE, BRYON, Chr. Hansen's Lab. Inc., 9015 West Maple St., Milwaukee, Wis.
SPITZER, GEORGE, 1000 Stadium Ave., West Lafayette, Ind.
SPRAGUE, WM. HERBERT, c/o Adohr Milk Farm, Tulare, Calif.
STARK, C. N., Dairy Bldg., Cornell Univ., Ithaca, N. Y.
STEBNITZ, V. C., 102 Dairy Annex, University of Wisconsin, Madison, Wis.
STEPHENS, DAN V., Fremont, Neb.
STEWART, G. F., Omaha Cold Storage Co., Omaha, Neb.
STOLTZ, R. B., Dept. Dairy Tech., Ohio State Univ., Columbus, Ohio.
STOOPS, WILLIS P., Wooster Farm Dairies, Wooster, Ohio.
STORVICK, R. O., Iowa State Brand Creameries, Inc., 1027 2nd St., S.W., Mason City, Iowa.
STRACHAN, ROBT. C., 17800 Valley View Ave., Cleveland, Ohio.
STROUD, L. E., Sunshine Farm, Great Falls, S. C.
SUNFORS, E. H., Route 2, Box 118U, Stockton, Calif.
SUPPLEE, G. C., Research Lab., Dry Milk Co., Bainbridge, N. Y.
SUTERMEISTER, L. A., The Red Wing Corp., Dayton, Ohio.
SWANNER, ROY O., Bureau of Milk Sanitation, State Department of Health, Albany, N. Y.
SWEETING, BERT, Medosweet Dairies, Tacoma, Washington.
SWEM, MRS. T. DALE, Nutrition Director, St. Joseph Valley Unit, National Dairy Council, 219 Pythian Bldg., South Bend, Ind.
SWIFT, H. L., Produce Operating Dept., U. S. Yards, Chicago, Ill.
SWOPE, W. D., Dept. of Dairy Husb., Penn. State College, State College, Pa.

T

TAUB, JOEL, 40 E. 17th St., Brooklyn, N. Y.
TAYLOR, K. P., Route 2, Moscow, Idaho.
TAYLOR, MARVIN L., Harding Cream Co., Omaha, Neb.

TEMPLETON, HUGH L., Hiram Smith Hall, College of Agri., Madison, Wis.
THOMPSON, E. C., Bordens Milk Products Co. Inc., 15 Renwick St., New York, N. Y.
THOMSEN, L. C., 1527 Jefferson St., Madison, Wis.
THOMSON, A. C., Farm Bureau Office, Washington, Kansas.
THORNTON, H. R., Dept. of Dairying, University of Alberta, Edmonton, Alberta, Canada.
THURSTON, L. M., Dept. of Dairy Husb., College of Agri., West Virginia Univ., Morgantown, W. Va.
TINKER, PAUL F., Rouses Point, N. Y.
TITUS, R. W., Control Lab., Nestles Milk Products, Inc., Marysville, Ohio.
TOBEY, JAMES A., Director of Health Service, The Borden Co., 350 Madison Ave., New York, N. Y.
TORGESON, H. E., 3870 17th St., San Francisco, Calif.
TRACY, PAUL H., Dept. of Dairy Husb., Univ. of Illinois, Urbana, Ill.
TRELOGAN, HARRY C., Division of Dairy Husb., Univ. of Minnesota, University Farm, St. Paul, Minn.
TREON, CHARLES W., 1004 West Norwegian St., Pottsville, Pa.
TRETSVEN, J. O., Dairy Specialist, Mont. State College, Bozeman, Mont.
TROUT, G. MALCOLM, 138 University Drive, East Lansing, Mich.
TROY, H. C., Cornell Univ., Ithaca, N. Y.
TRUE, N. F., Mead, Johnson & Co., Evansville, Ind.
TUCKER, HUBERT, North Jersey Expt. Sta., Sussex, N. J.
TUCKEY, STEWART L., 101 Dairy Mfrs. Bldg., Univ. of Illinois, Urbana, Ill.
TURK, KENNETH L., Dept. of Animal Husb., Cornell Univ., Ithaca, N. Y.
TURNBOW, G. D., 1404 Franklin St., Oakland, Calif.
TURNER, CHARLES W., Dept. of Dairy Husb., Univ. of Missouri, Columbia, Mo.
TURNER, S. C., Maricopa Cry. Co., Phoenix, Ariz.
TWINING, F. M., 198 N. Chancellor St., Newton, Pa.
TYLER, HOWARD S., Conn. Junior Republic, Litchfield, Conn.

U

USSELMAN, W., Galloway-West Co., Fon du Lac, Wis.

V

VAN HORN, R. C., Champlain Milk Prod. Co. Ltd., Stanbridge Station, Quebec, Canada.
VON LANGE, OSCAR, Soledad, Calif.
VAN NORMAN, H. E., 5844 Stony Island Ave., Chicago, Ill.

W

WAGGONER, RALPH W., Columbia Coop. Dairy Assn., Clatskanie, Ore.
WALMSLEY, F. D., Borden's Farm Prod. Co. of Illinois, 3638 Broadway, Chicago, Ill.
WALTS, CHARLES C., 110 Bridge St., Brooklyn, N. Y.
WALTZ, R. G., Room 20, Curren Arcade, Norristown, Pa.
WARD, RUEL E., 748 College Station, Pullman, Wash.
WARD, FRED C., Nat. Dairy Products Inc., Research Lab., 1403 Eutaw Place, Baltimore, Md.
WARE, L. D., Mgr. Richmond Coop. Assn. Inc., Richmond, Vt.
WATERSTREET, NEAL, c/o The Grade, Asylum St., Hartford, Conn.
WATSON, PAUL A., 3255 Foothill Blvd., Pasadena, Calif.
WATT, A. L., Northern Great Plains Dairy Sta., Mandan, N. D.
WATTS, C. A., Apt. 3, 8732 Harper Ave., Chicago, Ill.
WEAVER, EARL, Okla. A. & M. College, Stillwater, Okla.

WEBB, BYRON H., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
WEBSTER, DUDLEY B., Box 955, Glenodale, Ariz.
WECKEL, KENNETH G., 1546 Jefferson St., Madison, Wis.
WEED, THEODORE H., 566 Bank St., St. Albans, Vt.
WEISER, HARRY H., Dept. of Bacteriology, Ohio State Univ., Columbus, Ohio.
WEISSERT, A. D., c/o Schlosser Brothers Cry., Plymouth, Ind.
WELCH, R. C., Dairy Dept., Penn State College, State College, Pa.
WELCH, R. R., Dairy Ext. Specialist, Penn. State College, State College, Pa.
WETTLING, G. R., 163 West Avenue, Fairport, N. Y.
WHITAKER, R., National Dairy Products Corp., 1403 Eutaw Place, Baltimore, Md.
WHITE, ALLAN R., White Bros., North Quincy, Mass.
WHITE, G. C., Storrs, Conn.
WHITE, WILLIAM, Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
WHITE, W. T., Kodiak, Alaska.
WHITE, W. W., Snedekerville, Pa.
WICKHAM, J. C., 1905 Cypress St., Cleveland, Ohio.
WIESENBERGER, ARTHUR C., Chippewa Hills, Brecksville, Ohio.
WILBUR, J. W., Smith Hall, Purdue Univ., Lafayette, Ind.
WILLIAMS, G. A., Purdue University, West Lafayette, Ind.
WILLIAMS, OWEN M., 1137 11th Ave., Huntington, W. Va.
WILLIAMS, PAUL S., Dept. Dairy Husb., Pa. State College, State College, Pa.
WILLMANN, JOSEPH, Derby, Conn.
WILLARD, H. S., College of Agri., University of Wyoming, Laramie, Wyoming.
WILSON, H. L., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
WILSON, H. KENNETH, College City Division, Beatrice Meadow Gold Dairies Inc., Galesburg, Ill.
WINKJER, J. G., Bureau of Dairy Industry, U. S. D. A., Washington, D. C.
WILSTER, G. H., Oregon State Agri. College, Corvallis, Ore.
WOOD, HARRY M., 925 Bond St., Green Bay, Wis.
WOODS, G. F., Fairview Dairy, Rt. 1, Box 354, Tucson, Ariz.
WOODS, HEBER O., 2220 Oak Glen Place, Los Angeles, Calif.
WOODWARD, EDWIN G., Dairy & Food Commissioner, State Office Bldg., Hartford, Conn.
WRIGHT, ERSKINE C., The Dairy Laboratories, 2615 Olive St., St. Louis, Mo.
WYENO, JURO, S. M. A. Corp., Mason, Mich.
WYLIE, C. E., Univ. of Tennessee, Knoxville, Tenn.

Y

YALE, M. W., New York Agri. Expt. Sta., Geneva, N. Y.
YAWGER, E. S., Dairy Industry Bldg., Cornell Univ., Ithaca, N. Y.

Z

ZAKARIASEN, BEN., 2201 Kennedy St., Minneapolis, Minn.
ZAVAGALI, V., Laboratorio della Samita, Piazza Vittoris Emmanuelle, Rome, Italy.
ZIEGLER, PAUL D., Inspector Milk & Cream Testing, 417 Arlington St., Tamaqua, Pa.

AMERICAN DAIRY SCIENCE ANNOUNCEMENTS

Length of Manuscripts

The Board of Directors at its last annual meeting passed the following resolution which was approved by vote of the membership attending the business session in Ithaca on June 27:

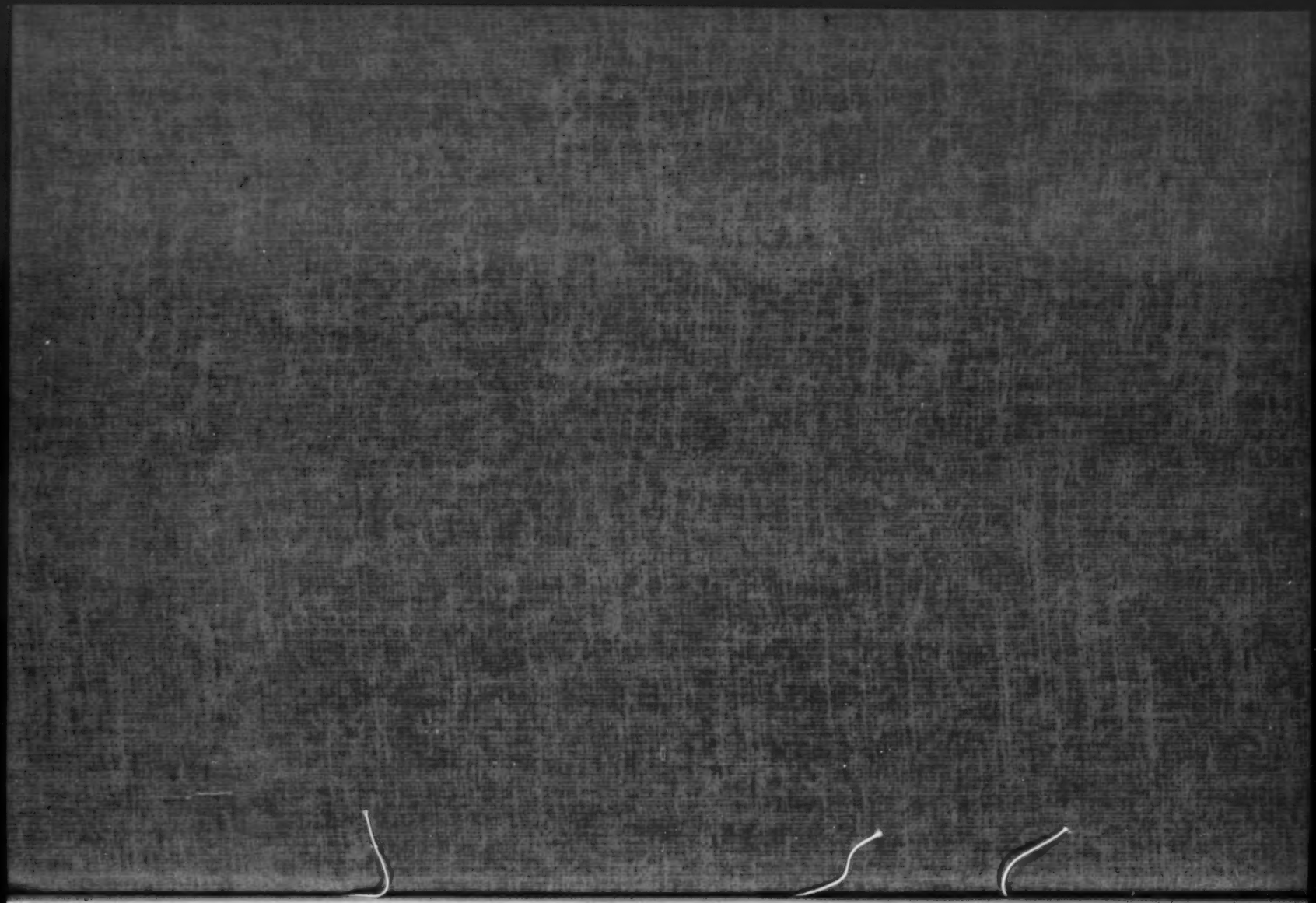
"*Resolved,* that the Editor limit all articles to 12 text pages except for articles of unusual merit."

In addition, and in view of the fact that many colleges and Experiment Stations are now buying space in other Journals, the Journal will accept meritorious articles of extra length on the condition that papers in excess of 12 text pages (about 16 double-spaced typewritten pages) will be paid for at the rate of $4.00 per text page.

Authors May Secure Cuts for Illustrations

Cuts for all graphs and pictures of articles published in the Journal may be secured free by authors who request them from The Science Press Printing Company. The first of each year the old cuts on hand will be destroyed.

Engineering Papers for Next Year's Program

The following statement has been received from L. S. Palmer, chairman of the Program Committee, regarding dairy engineering papers for the annual meeting which will be held next year at the University of Minnesota:

"The program committee for the 1935 meeting of the American Dairy Science Association announces that members of the Association interested in dairy engineering and who desire that this subject be given special consideration at the next meeting may be assured that worthy papers in this field which are submitted for the program will either be given a special place in the manufacturing or production sections, depending upon the topics, or if sufficient interest is shown, will be arranged in the form of a special symposium."